. . . Presenting New Ideas and Methods in Lighting for Display, for Atmosphere, for Decoration and for Utility in Places of Amusement . . .

Theatre Lighting

GENERAL ELECTRIC
COMPANY
NELA PARK ENGINEERING DEPARTMENT
CLEVELAND, OHIO

FOREWORD

Of the more than sixteen thousand theatres operating in the United States all but a few hundred are primarily engaged in the presentation of motion pictures. They are visited each week by a majority of the country's population and the aggregate admissions for this entertainment make the theatre business a leading industry.

The enterprising theatre is more or less a centerpiece in community life. It reflects alertness, becomes a considerable element in civic pride and civic stimulation, and, in fact, is often an important influence in the competitive aspects between towns or communities.

This bulletin is offered as a digest of techniques and methods of applying light in new and interesting form particularly to the theatre, whose enterprise traditionally has done so much to give it ranking in community importance. Not exhaustive as a technical design manual because other publications serve that need, this bulletin says frankly

To the Theatre Operator:

New and better methods of lighting will transform your theatre, attract patronage, and be a source of pride to the community.

To the Architect, Designer and Decorator:

Lighting properly handled is the most versatile of all architectural and decorative elements affording the full range of force and subtlety that the elements of brightness, motion, color, alone can achieve.

To the Lighting Engineer and Technician:

A comprehensive understanding of materials, light sources, equipments, is essential to effective and efficient lighting results.

Theatre Lighting

by FRANCIS M. FALGE and C. E. WEITZ

. . . presenting new ideas and methods in lighting for display, for atmosphere, for decoration and for utility in places of amusement . . .

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The Portico of The Confederacy, Hall of Transportation, Dallas Exposition, typifies lighting as a fine art.

To the static beauty of building materials the designer may add the fluidity of light and color—subdued, bold or vitalized with vibrant mobility. Buildings thus treated are more commanding, more beautiful by night than by day.

To design for natural light is an old precept with architects; to design *with* light is a new and startlingly different concept; matching the theatre's traditional pioneering, the current era of Expositions has glorified Light and Color as an indispensable condiment to give relish and atmospheric seasoning to the entire undertaking. And millions of people experienced its beauty and fascination.

Expositions such as Chicago, San Diego, Dallas, Cleveland, have served both as vehicles for the presentation of advanced ideas and as proving grounds of public reaction. Out of these experiences have come sound principles of design and effects that are forceful and appropriate to the theatre and other amusement places.

Light and Color quicken the spirit, transport one into fanciful new worlds, fires emotions. These qualities are the very powers the successful show place must command.

Theatre Lighting

Many of us can recall the stately "opera" houses which stood so dead and forlorn on so many Public Squares and Main Streets twenty years ago. They had not been able to meet physical requirements for profitable showing of motion pictures. The "opera" houses had generally lived their day, and they probably deserved extinction as architectural eyesores. Certainly entertainment custom had changed so radically that these old places were beyond repair.

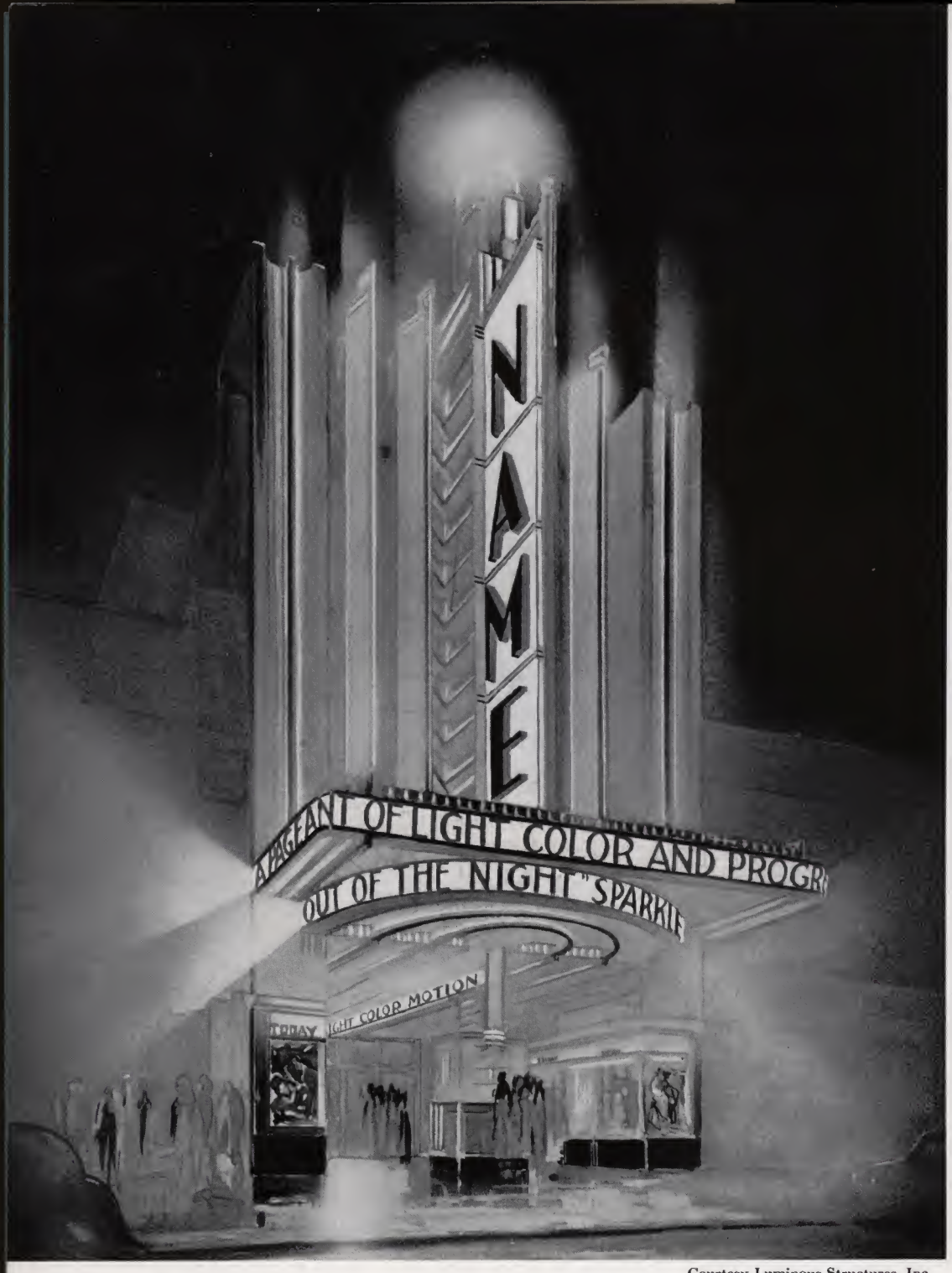
Newness is the essence of show business now much more emphatically than ever before. People in the remotest sticks see fine talking pictures of Broadway hits much more promptly today, and they view them with a hitherto unknown sophistication. They hear radio presentations while the shows are still the talk of Manhattan.

Proprietors of leading movie houses are sensitive to the demand for newness. To a public that exhausts the humor of a comedian in a few years, a shabby, dated theatre is the end of box office. In some businesses you can still be quaint and pay tribute to the past by training ivy on the facade of your building. Such businesses are the exception.

A public which looks to new models in automobiles every year, patronizes stores which employ the best "theatre" in their presentation of merchandise; and in the theatre business, a fashion-conditioned public is always looking for new evidence of thoughtfulness. Lighting provides perhaps the most abundant source of new things from which the theatre can derive a gratifying response.

New theatre construction will, as a matter of course, embrace the new modern methods of lighting both on the exterior and on the interior. Old theatres, vitally needing modernization to keep them in a competitive position, must necessarily give attention to lighting as a principal theme of design. To what extent both new and modernization projects capitalize on lighting and how effectively they use it will depend largely on their familiarity with the new forms, new materials and new light sources, and the skill with which they adapt these to their particular problem.

This bulletin therefore presents important data and information, together with suggestions and illustrations from the field and from the drafting board.



Courtesy Luminous Structures, Inc.

Characterized by a smartness rarely found in pre-depression days, are the new theatre fronts which are being installed in increasing numbers today. These fronts, incorporated as a definite part of the design of the building achieve not only impressiveness and refinement but strong commercial advantage. New equipments and new lighting methods have been developed to enable the theatre to get the maximum benefit with minimum cost.

A THEATRE FRONT THAT IS REALLY EFFECTIVE

There are several distinct features which a modern front should possess if it is to have maximum appeal and value:

It should attract attention from afar.

It should stand out by contrast from surrounding displays because of its brightness and color.

It should create a favorable impression by pleasing design.

It should have movement and sparkle.

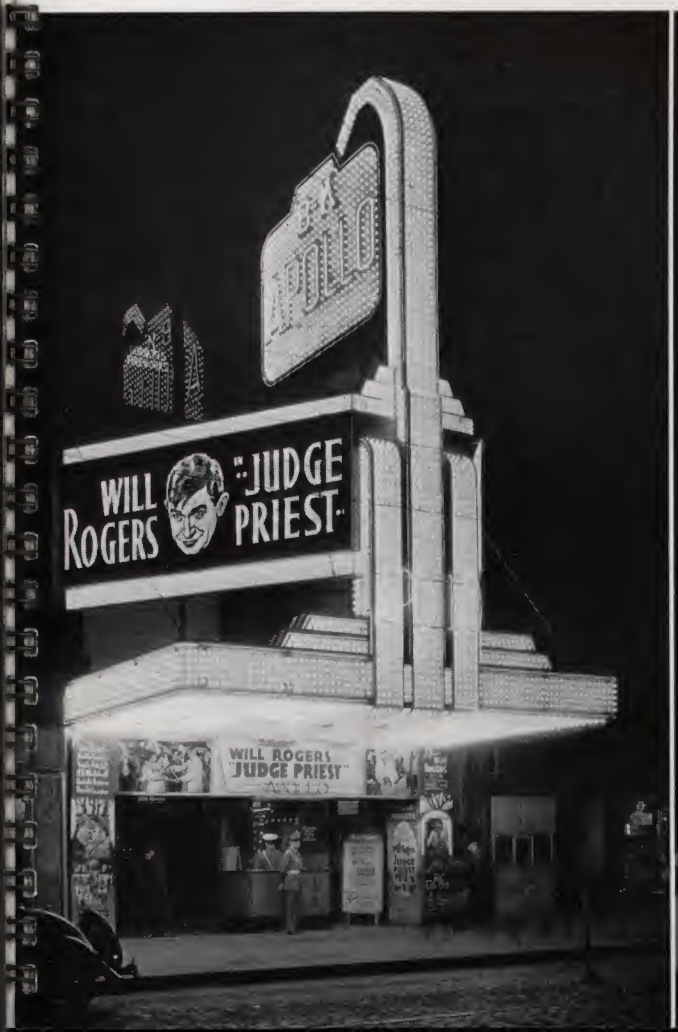
The name of the theatre should be clearly legible from all strategic points.

It should sell the theatre and its program and meet the competition of its surroundings.

Changeable attraction letters should unmistakably "bulletin" the presentation.

The underside of the marquee should be bright and sparkling, leading customers right up to the ticket windows.

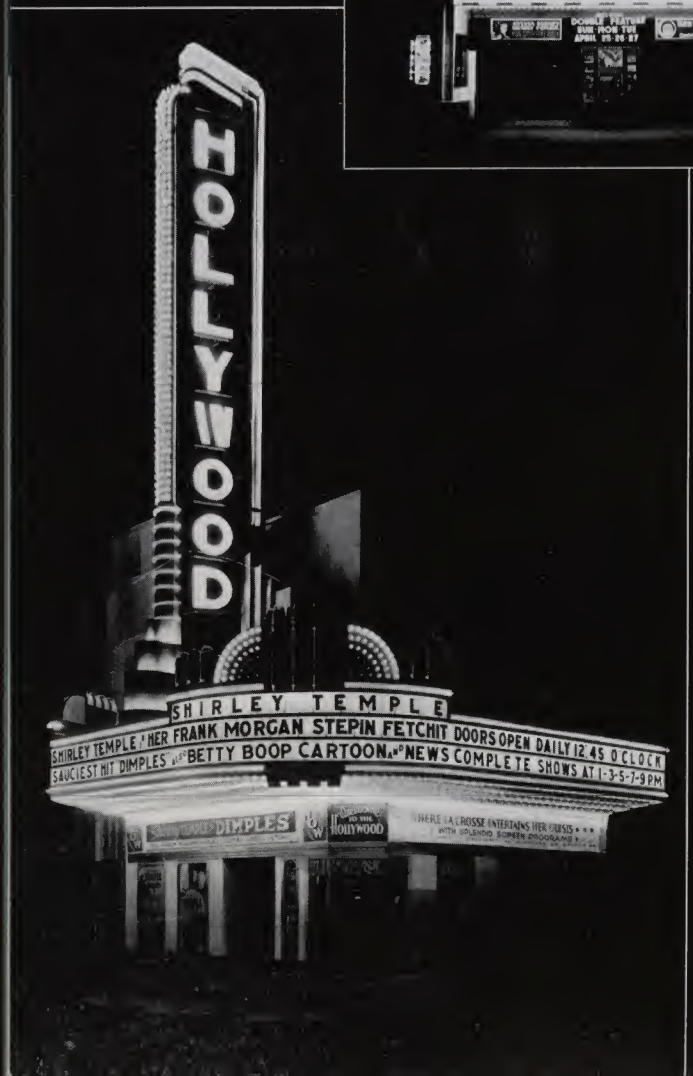
A few examples, large and small, of new or remodeled fronts which bear these points with individuality and distinction are pictured here. To be lasting and effective the various elements must be well composed into a pleasing balance with harmony of line and mass. Modern design implies a break with traditional "tacked on" feeling of marquee and vertical sign. The problem is to avoid bizarre or freakish treatment—to achieve a treatment of the entire front that is pleasing architecturally at night as well as by day. At the same time it must stand analysis from the standpoint of the commercial requirements outlined.




PARK
"OUTCAST"
WARREN WILLIAM
KAREN MORLEY
AND SHORT SUBJECTS
BANK NITE WED. & SAT.


TRICHLER


MICHIGAN
CHAMPAGNE WALTZ FRED MAC MURRAY
JACK OAKIE · VELOZ YOLANDA
DANGEROUS NUMBER ROBERT YOUNG


HOLLYWOOD
SHIRLEY TEMPLE
SHIRLEY TEMPLE IN HER FRANK MORGAN STEPIN FETCHIT DOORS OPEN DAILY 12 45 O'CLOCK
SAUCIEST HIT DIMPLES AND BETTY BOOP CARTOON AND NEWS COMPLETE SHOWS AT 1-3-5-7-9 PM
DIMPLES
HOLLYWOOD


GATEWAY
GATEWAY
Publix
THE SCREEN'S GREATEST PHOTOPLAYS
EARLE ESTES AT THE ORGAN
SUN. NORMA SHEARER LET US BE GAY

▼ Before and After ▶

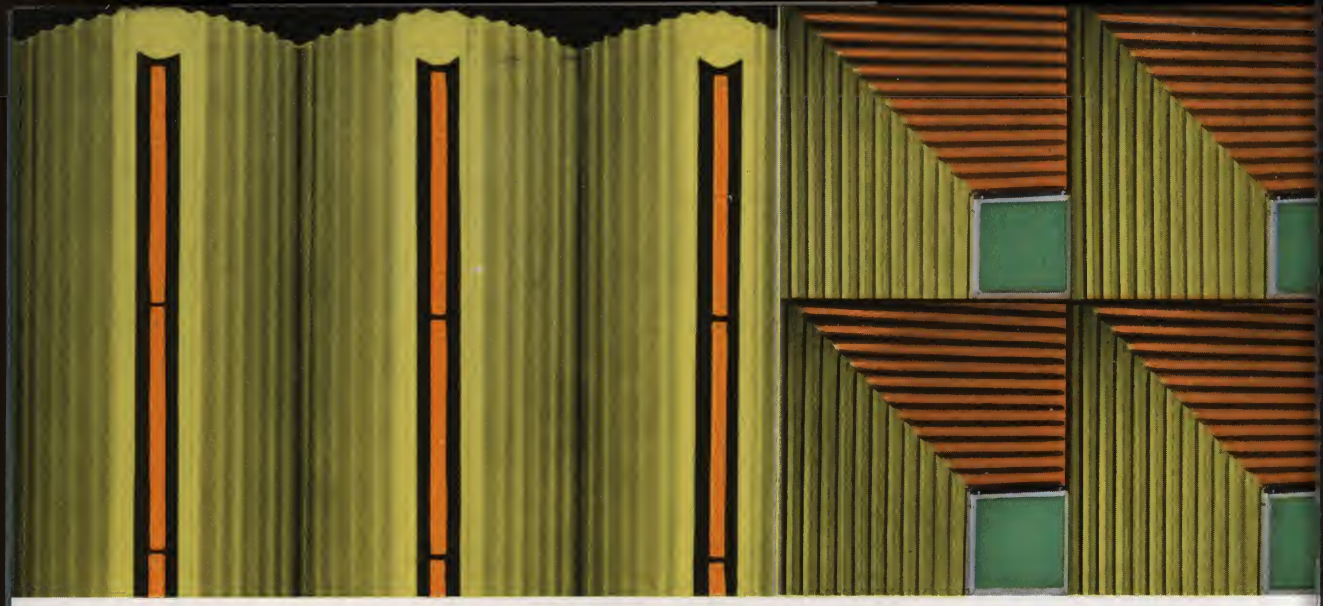
MODERNIZING WITH LIGHT

Architectural design involves the knowledge of emotional appeal and psychological effects. If the choice of materials and the handling of them produces graceful proportions in line, form, and mass, if colors and materials blend, if contrasts are pleasing so that individuals react favorably to these results and regard them as beautiful, then we have effective design. According to newer concepts, many buildings considered satisfactory some years ago are now seen to be decidedly ungainly, awkward and totally inadequate commercially in their expression and outlook. Commercial buildings, particularly theatres, should be architecturally pleasing, and it must be recognized that they must advertise and compel attention.

Today there is a wealth of new building materials to inspire new concepts in architectural design. For sparkle and scintillation the lighting designer now has at his disposal durable, lustrous reflecting metals. Add to these the new translucent materials—marble, plastics, new glasses, glass block, rods, tubes and moulded forms, in a wide range of colors. Add also, the new light sources—new types of incandescent lamps, electric discharge lamps of startlingly new concept, and we have an entirely new order of flexibility in facilities at the disposal of the creative designer.

On the following pages are illustrated a number of lighting elements that can be disposed in line, area or mass to fit design ideas for both exterior and interior treatment. The various combinations of lamps and materials are limited only by the ingenuity of the designer.

▼ Before and After ▶



Large areas of weather-resisting metals lend themselves to interesting design in coordination with light and color. At the left, curved sections of mat-finished corrugated metal lighted by silhouette troughs with accents of contrasting color by inserting strips of colored glass. At the right, porcelain enameled sections with corrugations at right angles are "painted with light" by supplementary colored floodlighting. Inserts of light boxes covered by translucent material serve as rhythmic accents for sparkle and highlights.

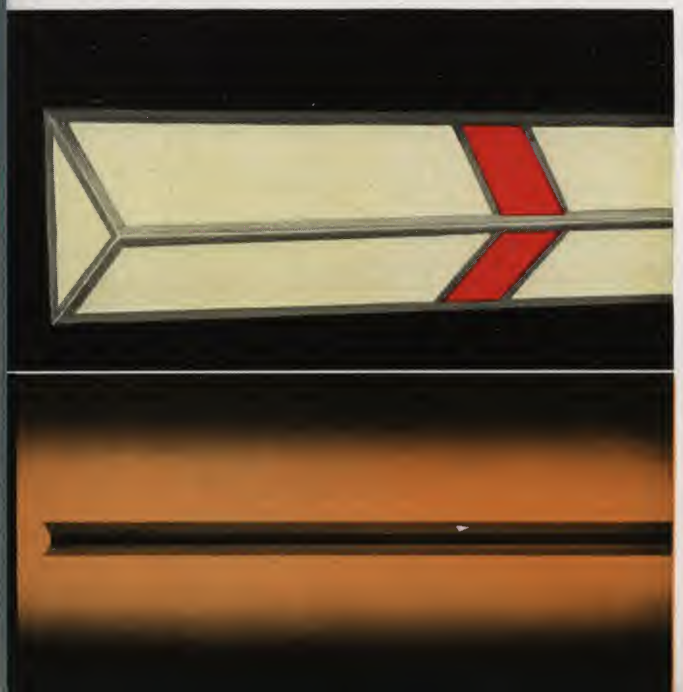
LARGE LUMINOUS AREAS

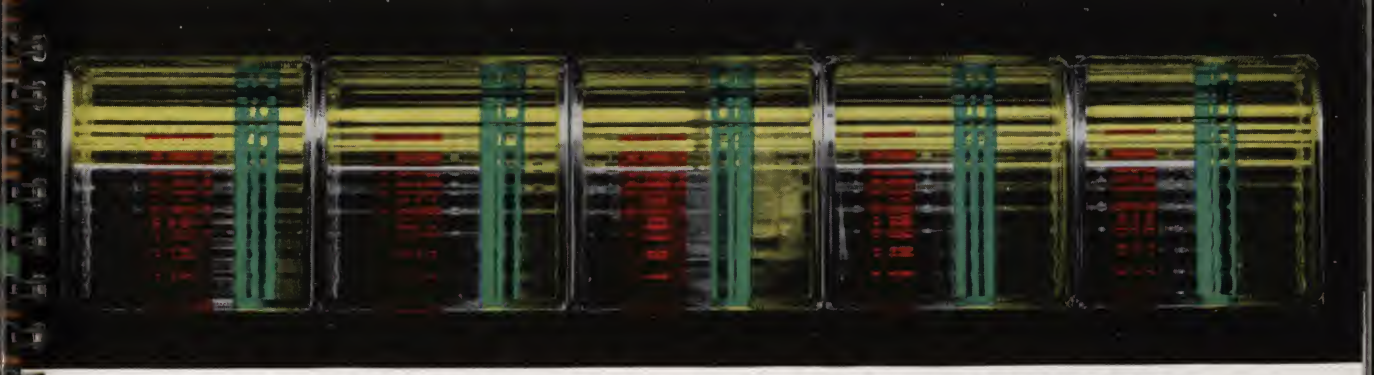
Reflecting Metals, Enamels, Paints, Plaster

Illuminating the entire front of the building is an important requirement of effective theatre advertising. Too often, by night when theatres need advertising most, the theatre is identified only by signs which do not proclaim the importance or magnitude of the establishment.

With today's freedom in architectural styling the surpassing effectiveness of large illuminated areas can be achieved by a number of practical means. Lamps concealed in stepped coves or in silhouette strips produce smoothly luminous areas when diffusing materials are used; shiny

Illuminated columns, pilasters, or beams may be enclosed luminous elements, or they may be simple lines or areas employing narrow silhouette reflecting troughs, concealing the lamps. At right, overlapping sections of reflecting background with lamp recesses are simple in construction and present a highly effective means of tinting with light, either in a single color or in separate bands of contrasting color.





The multiple bands of color in these glass blocks are produced through the lens action of the fluted block by two colored Lumiline lamps, one vertical, the other horizontal; an accent in a third color is introduced by the use of a 10-watt colored lamp.

or specular materials are used for sparkle and highlight effects. Corrugated metals floodlighted in color produce attractive luminous textured surfaces.

Glass Blocks

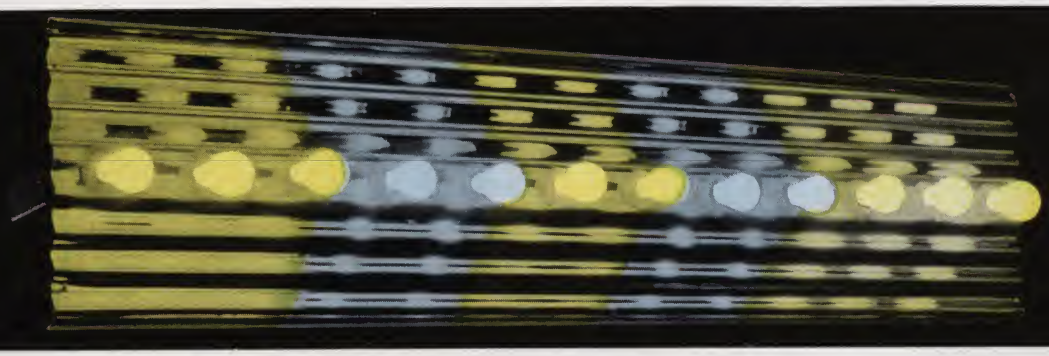
Glass blocks are now well-established products for many structural and decorative uses. In appearance the blocks may be textured in any fashion by the flutes, prisms or other surface embossing, each design of which lends itself to an infinite variety of color patterns. The prismatic action of certain embossed surfaces may produce a riot of colorful highlights, or if rather large fluted forms are used, more orderly patterns are possible, such as the scotchplaid effect in the illustration above.

The size of the bands and their spacing and emphasis is regulated by the lamp spacing from the glass, and whether reflecting backgrounds are used. Natural colored lamps in concentrating reflectors produce sparkle, coated lamps a somewhat softer effect. Diffuse reflecting backgrounds minimize the patterns of light; polished metal, corrugated or crinkled, introduces sparkle.

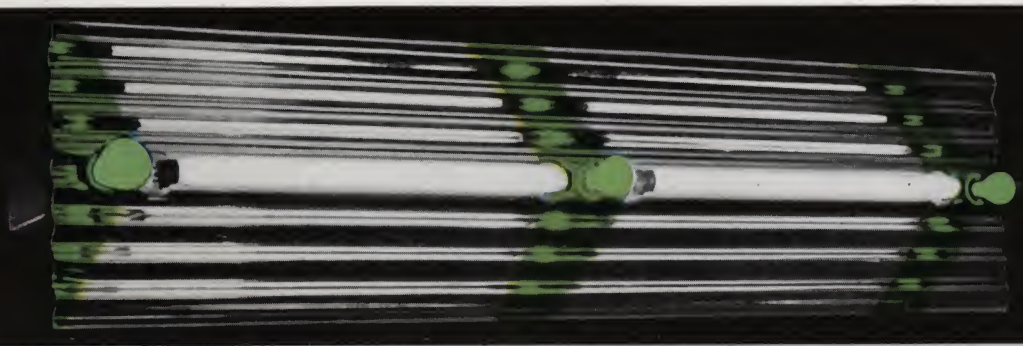
Two splendid examples of luminous structural glass block, equally suitable for interior or exterior applications.

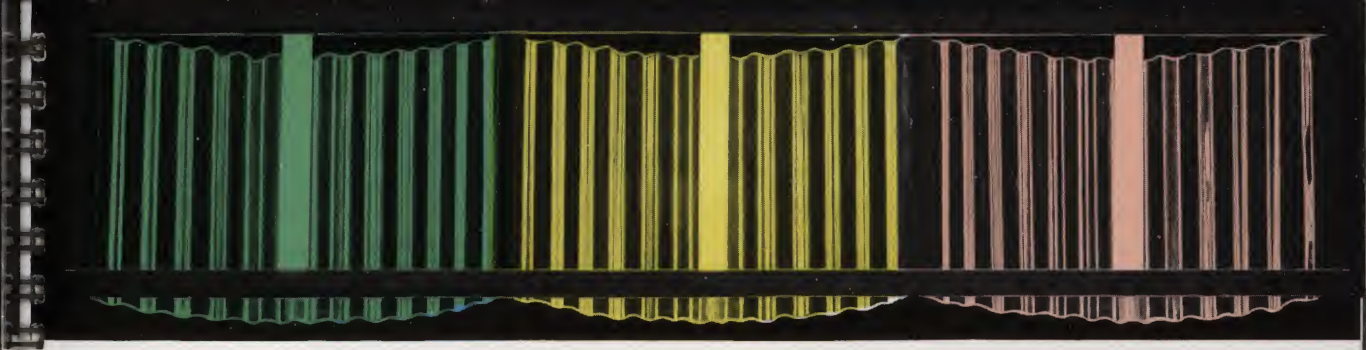
Parabolic sections of polished metal between lamps produce a line or band of light with highlight accents by the lamp itself. More light is projected into useful angles and color may be changed at will to provide rhythmic variations.

Multiplied value of a single row of lamps in a reflector trough with sloping sides. Now possible because of durable, weather-resisting metals which retain their finish.

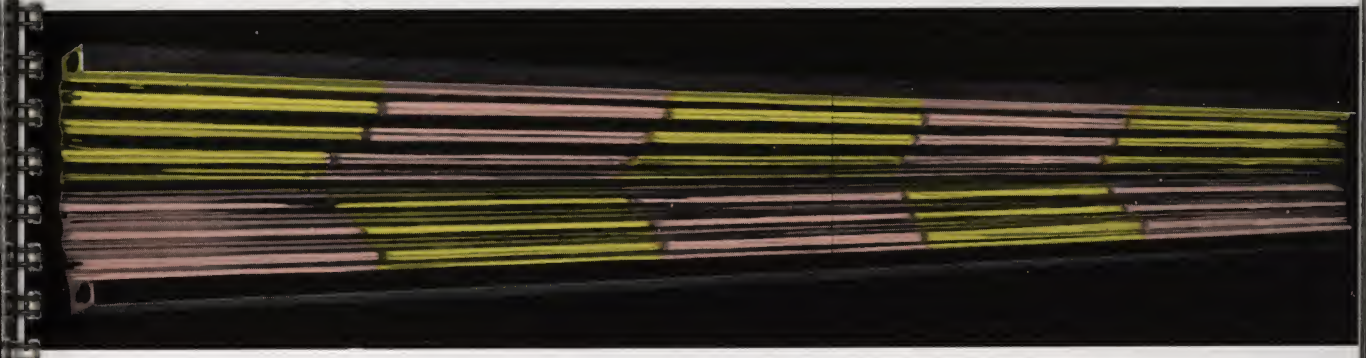


Polished corrugated metal backgrounds mirror the reflection of the lamps into countless sparkling sources. The reflected light is spread out in one direction only so that the bands of light produced are as wide as the source itself. With clear, diffusing, and extended sources, almost limitless variation in color and pattern is possible. Lumiline lamps may be alternated with ordinary lamps to produce highly individualized effects.

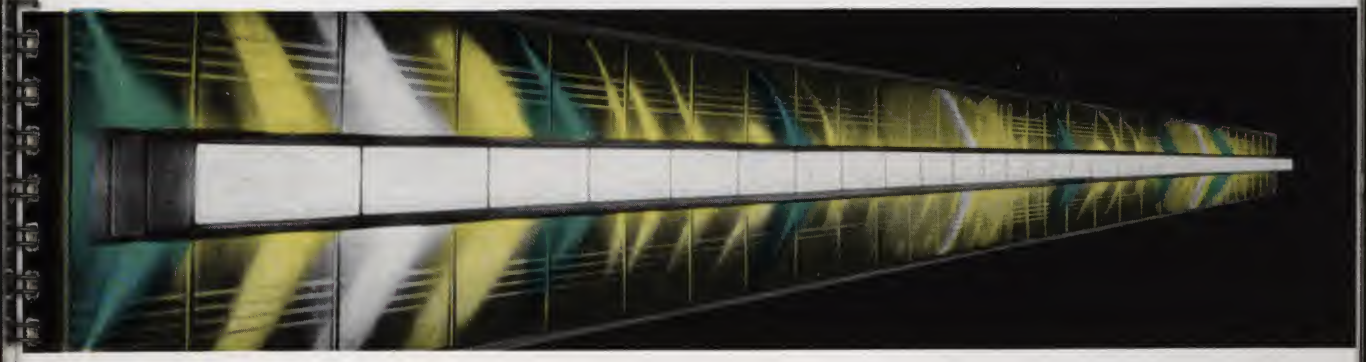




An effect produced by using Lumiline lamps at the focal point of curved sections of polished corrugated metal. The crest of each corrugation picks up the reflection of the lamp multiplying the effect by producing a series of long stripes. Alternating colors in adjacent sections produce attractive color contrasts. Another suggestion is to conceal the lamp at the edges of the corrugated reflecting background (below).



Heavy corrugations mirror highlights at each crest. A brushed polished metal (below) is in effect a surface with such minute corrugations that the appearance of the reflection is that of a continuous line or band. Highly interesting variations in form and color can be produced by mirroring lamps in brush-finished metals.



Small, low-wattage lamps aided by efficient individual reflectors produce high brightness effects suitable both for lines of light and for sign letters. Natural-colored cover glasses in stippled design are available in a wide range of colors of high efficiency; this makes possible the variety so desirable in advertising display.

Translucent marble in thin slabs is a rich, textured material, beautiful in its luminous effect.

Glass, Plastics, Marbles

This group of translucent materials offers a wide range of surfaces from which the designer may make a choice of texture and color either for small decorative accents or for areas of substantial size. Both the unlighted and lighted appearance are factors in the choice along with considerations of efficiency, maintenance and cost.

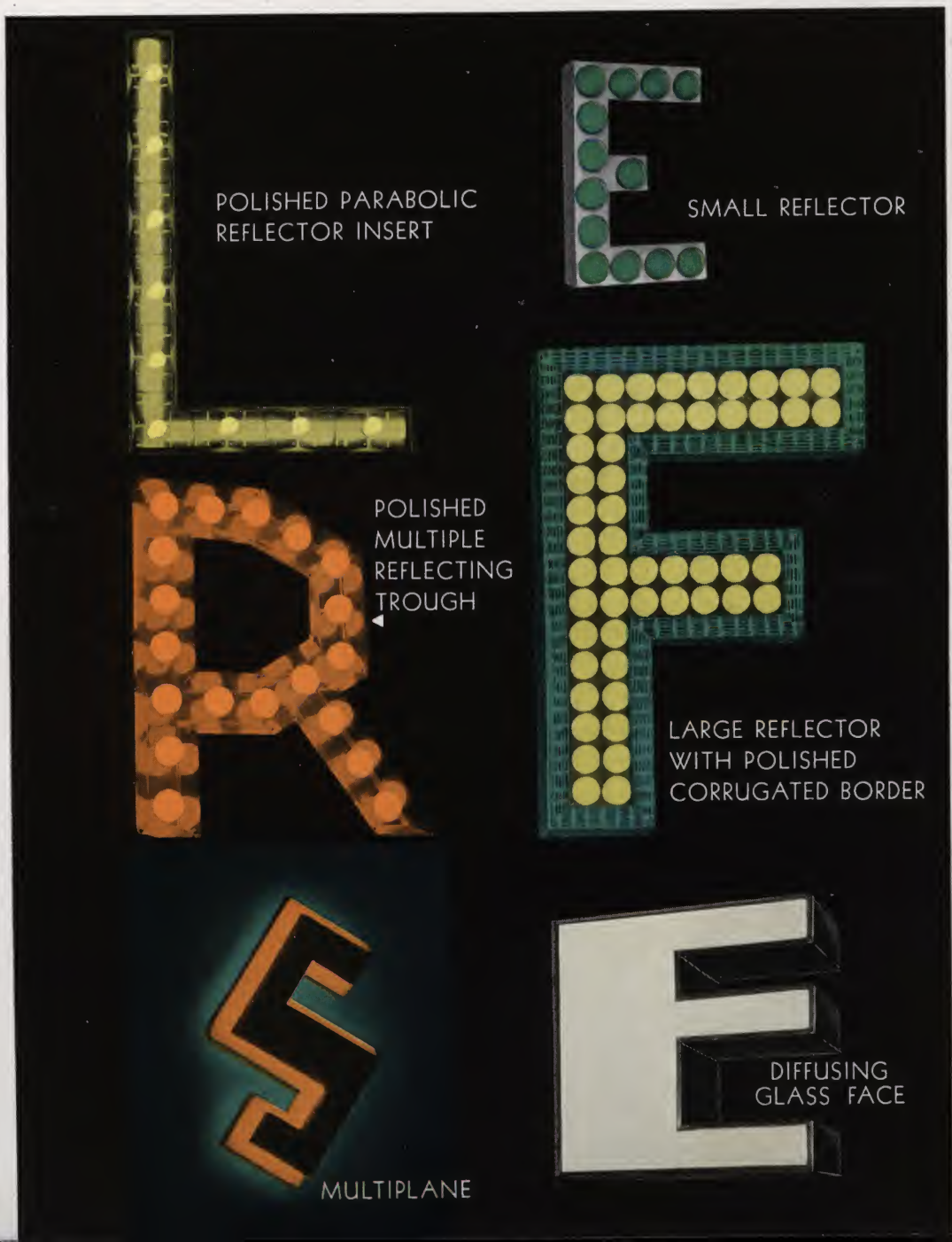
Translucent areas may serve both as decorative elements and for low brightness sources for utility lighting. They also form effective backgrounds for silhouette sign letters and patterns. Advertising messages and decorative patterns may be etched permanently in the material, or changeable silhouette letters and designs may be employed.

Luminous glasses and plastic forms are widely variable in texture, brightness or color. Advantage may be taken in decorative composition of the many types of transmitting materials—(See page 53)

New craftsmanship in moulded or cast glass for architectural and decorative purposes blends with the inherent eye appeal of brightness and color to achieve a fluidity of decorative expression.

Sign Letters for New Advertising Effectiveness

Individuality, color, brightness, motion, size and changeability are prime factors in effective electrical advertising. Above are some of the changeable attraction letters of the silhouette and luminous letter type, below some of the newer methods applied to letters for greater efficiency and distinction.



FLEXIBILITY OF DESIGN

A facade of overlapping vertical planes forming recesses for lamps to light each section. The luminous glass blocks and projecting sign combination ties in neatly with the design and commands attention at great distances.

It is possible to do little more than suggest the myriad combinations of elements, color and technique that is possible in achieving dominance and individuality in luminous display. Every creative designer has his own manner of dealing with the several elements of design. Every designer has at his disposal the elements of mass, form, area, texture, line, color and material which he must treat in relation to one another so that the composition is in harmonious balance. If a certain idea is to be expressed, the elements should be so arranged that those

Glass-faced block letters simply formed by oblong boxes or circular drums surmount the luminous facade in which the silhouette trough or lamp channels also serve as mounting for large changeable letters to feature special attractions.

A complete facade made luminous by curved panels of corrugated metal lighted by lamps in the vertical troughs. For additional attractiveness the troughs are faced with diffusing material contrasting in color with the background. The vertical sign is of the wedge type.

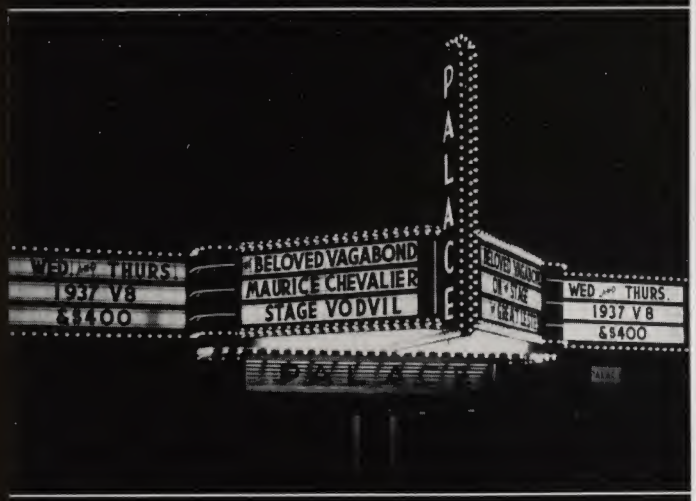
This theatre embodies a number of the new materials and architectural forms shown in the preceding colored illustrations. The impressive glass block tower is illuminated in ever-changing color by lamps on dimmers inside. Vertical exposed lamp sign letters are of the "sparkle" type operated by a four-circuit flasher. Attraction letters are of the silhouette type, lighted by MAZDA lamps.

that best express that idea are favored, while other elements are subordinated or removed. The proper blending of these elements is the test of design ability.

The sketches below merely suggest the versatility of modern luminous elements and how they might be employed in building front modernization.

A facade composed of alternated squares of mat-finished corrugated metal, floodlighted. Note the use of the newer corrugated metal elements as a cresting for the marquee and box office, and as a border for the vertical sign.

Another combination using "building-blocks" made up of horizontal and vertical corrugated pieces floodlighted in color. Inbuilt light boxes with translucent faces are located in the corner of each square. Polished corrugated metal is used as a cresting for the marquee and for the vertical sign.



MARQUEES

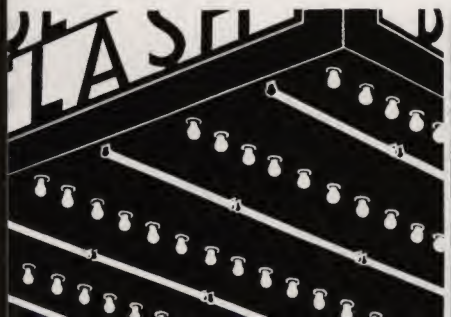
The marquee and attraction signs have become the familiar badge of the theatre. The extended, brightly lighted areas of the newer forms of luminous marquee treatment give them a value much greater than that of older forms.

Marquee signs should bulletin attractions dominantly and legibly not alone to sidewalk traffic but to vehicular traffic as well. In this respect some projection of the display is of major concern. On smaller buildings or narrow streets not allowing large marquee structure, this is achieved by the triangular-shaped design now available in factory-fabricated units.

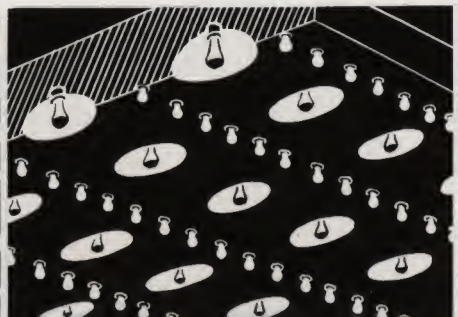
Luminous backgrounds for silhouette changeable copy may be either open cavity or glass faced. The principal lighting requirement is uniformity of brightness and elimination of spottiness. This makes for legibility and quick reading; spottiness causes variable irradiation which blurs or distorts the outlines of the silhouette letters. The brightness of the luminous background should be regulated by the general street illumination and the brightness of competing displays. Exposed lamp signs, particularly those employing reflectors may best be used where the values of dominance and attention are demanded.

New and novel effects can be obtained by the use of designs of the character sketched below.

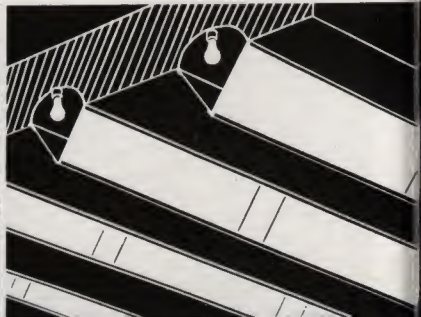
Alternate rows of A-bulb and MAZDA Lumiline lamps.



Combination of exposed bulbs and flush-mounted reflector units.



Recessed trough cavity with V-shaped translucent elements.



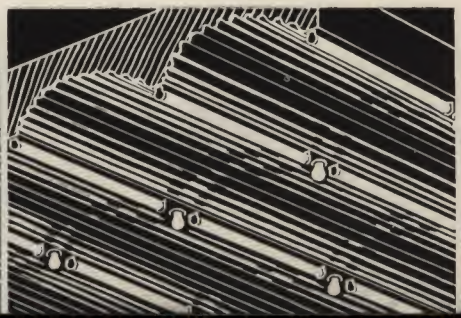
Soffit Treatment

The most obvious, the simplest, and often the best method of lighting the underside of the marquee is to ceil it with low-wattage exposed lamps. The purpose they serve, logically, is creating a festive spirit by their sparkle and brightness. Some systematic arrangement or geometric pattern of lamps is desirable. Such a pattern aims particularly to be pleasing, coupled perhaps with a motif directing attention toward the entrance. Sometimes, as in the upper illustration, the principal sign border is carried with flowing motion effect right down to the ticket booth. An arrangement of symmetrical studding of regular inside-frosted bulbs combined with lines of light from Lumiline lamps is very effective. Maintenance is simplified and additional sparkle is obtained by using enameled metal backgrounds in white or light tints.

Other possibilities are the use of flush-mounted reflector units with silvered-bowl lamps for high-level lighting beneath the marquee, combined with lines of exposed bulbs on 6-inch to 8-inch spacing to introduce brightness when viewed from down the street. In some instances the entire underside of the marquee has consisted of a large luminous glass panel; but often this does not present sufficient brightness unless combined with exposed lamps either as a soffit edging or by the abundant use of exposed lamps in the vertical sign and attraction sign borders.

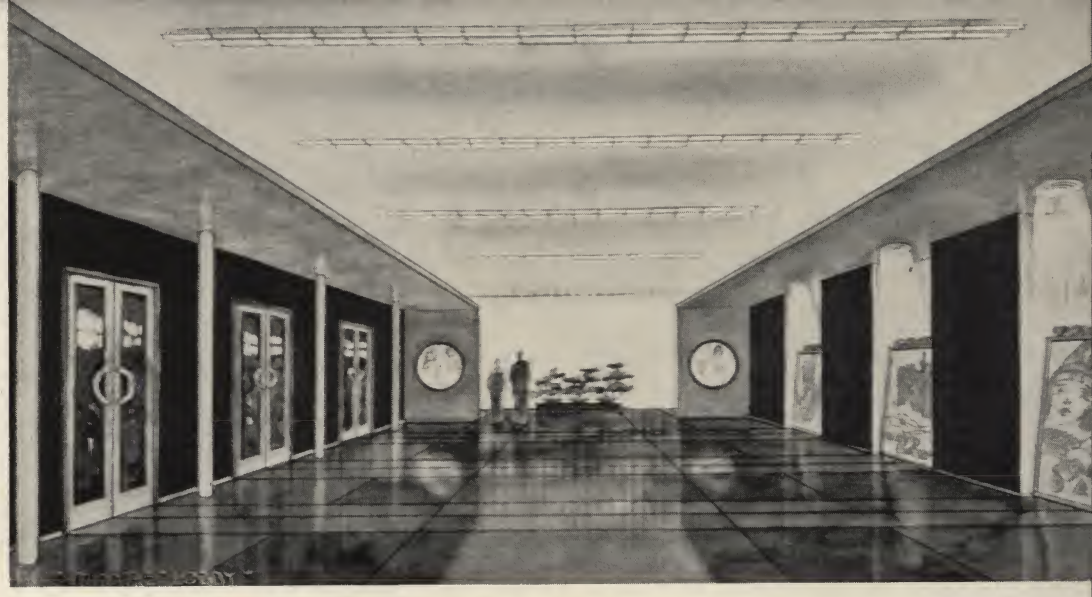
Flat corrugated polished metal backgrounds for exposed lamps.

Curved corrugated polished metal ceiling with MAZDA Lumiline lamps.



Large translucent panels bordered with exposed MAZDA lamps.

A striking lobby creation using as a decorative element silhouette strips concealing lamps which illuminate the surfaces behind them, interpreting the modern utilization of light in architecture. A treatment of this character is a worthy variation from the mammoth chandeliers which, in other circumstances, may serve admirably in scale and function.



The utmost in simplicity yet in decorative harmony are these ceiling elements of Lumiline lamps which strike a new note in this modern lobby. Posters are prominently lighted by spotlights with spill rings.

INTERIORS

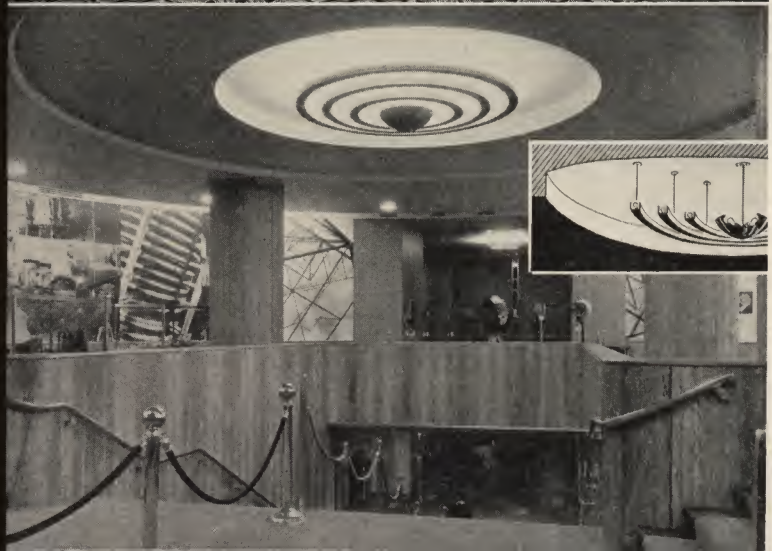
No entertainment place would by choice be drab, dull or depressing in its impression on its patrons. People go to the theatre for release from work-a-day environment. A great majority of the patrons relish as much as anything the sense of luxury and well-being in the setting, the colorful, stimulating atmosphere, and the carefree mood that these surroundings provoke.

The architectural style, decorative composition and furnishings are the basic elements of interest and appeal. But they are fixed and static. Lighting is a pervading, vitalizing force—vibrant and changeable as are moods and emotions. That is why many modern amusement places are designed structurally around the lighting system. That is why, too, lighting for the theatre cannot be standardized as might the lighting for an office or school. It can perform too many profitable functions for the theatre to be limited in its use.

Since so great a part of the purpose of lighting is to decorate and to stimulate moods and emotions, it would be presumptuous to say exactly how a theatre interior should be lighted. It is possible, however, to show by example a variety of methods; also to recite the principles which logically should dominate the various applications.

When planning the lighting for the interior of a theatre—the lobby, auditorium, foyers or promenades—practically every type or form of lighting may be considered. Whether to use conventional suspended fixtures, or built-in lighting in the form of coves, coffers, panels, beams, directional effects or projectors is largely a matter of coordinating with the interior design and decoration either as a principal motif or as an aid to enhance the general idea. In any case, both the ceiling and sidewalls, the balcony front and soffit must come in as adjuncts to the lighting treatment.

The principal concern from a design standpoint is to so coordinate the architectural elements as to size, brightness, color and control facilities, so that the entire ensemble will present a pleasing balance and harmony.



Left above—A circular lobby and lounge with photo-murals emphasized by a continuous line of control lens units set at proper angle to produce a band of light on the walls.

Above—An example of modern lighting in a setting of classical architecture. In addition to the suspended luminaires which light the decorative relief work, the ceiling is edged with a continuous luminous ledge of frosted glass. Six flush-mounted lens-plate units between each column highlight patrons at the mezzanine promenade railing.

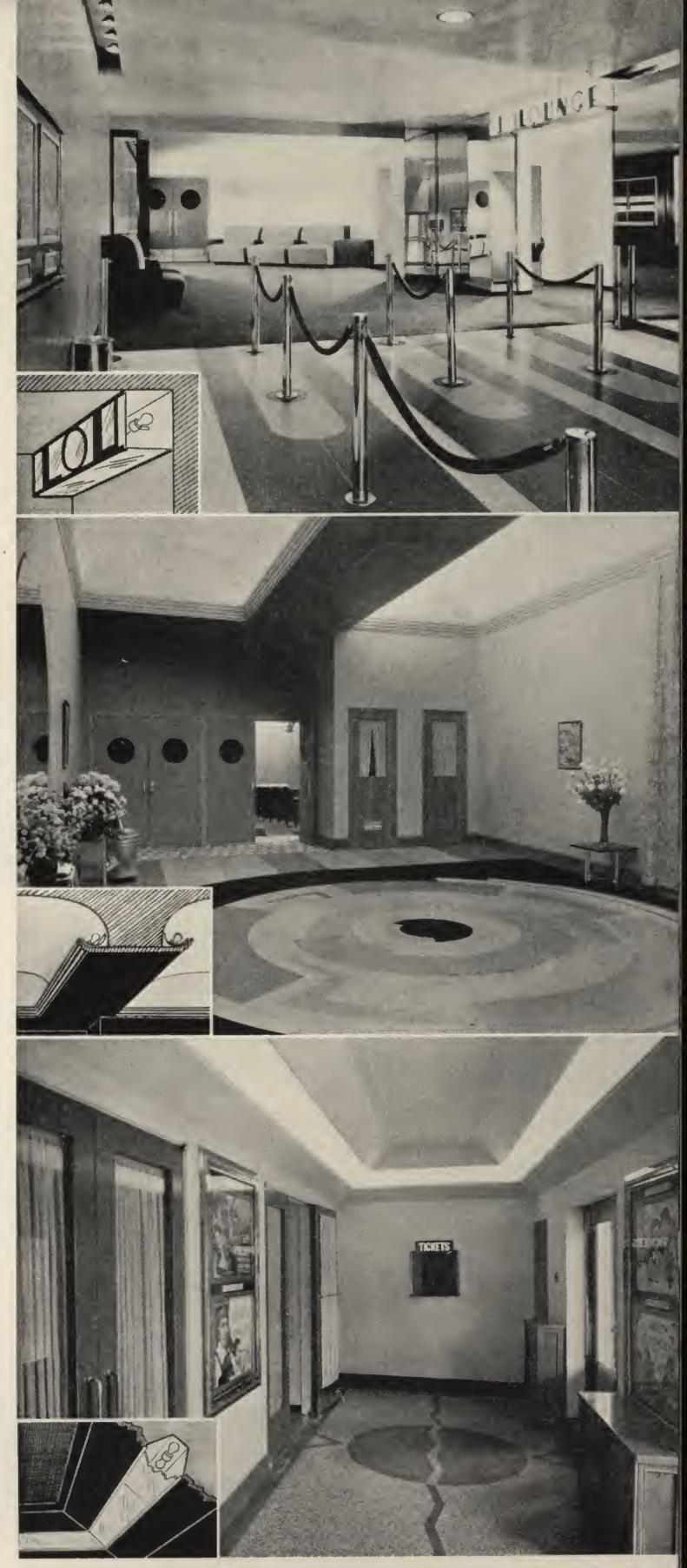
A simple lobby treatment employing a central ceiling dome or coffer of octagonal form to produce low-brightness, indirect lighting from lamps concealed around the edge.

The central ceiling unit of this room (another view of the room shown in the upper left corner) is a circular coffer lighted by lamps in concentric circular silhouette troughs—a scheme of lighting admirably keyed to the general architectural plan.

◀

Lobbies

The function of the outer lobby is principally that of a passageway to the inner lobby, or foyer. It is the first point of contact with the interior and should be interesting and impressive. The lighting, by whatever system, should create a feeling of spaciousness and freedom. This is accomplished by ceiling and wall areas of fairly high brightness of 20 to 50 foot-lamberts*; some life and sparkle in the lighting equipment is desirable. The requirement for general illumination levels of 10 to 20 foot-candles as measured on a horizontal plane, is adequate as an intermediate level to accommodate the eyes to the difference between the high level entrance lighting and the darkened auditorium. Since the wall area is effective advertising space for coming attractions, provision should be made for highlighting these displays with an adequate scheme of lighting.



Above—Flush-mounted ceiling units provide general utilitarian lighting; the wall display area at the left is highlighted with concentrating reflectors set into the ceiling cavity. Note also the luminous element marking the lounge entrance.

Middle—The broad architectural beam in silhouette provides the location for lamps for the indirect illumination of ceiling and sidewalls.

Right—This small entrance lobby is lighted by a continuous rectangular cavity conforming to the architectural plan with lamps behind cased-opal glass panels.

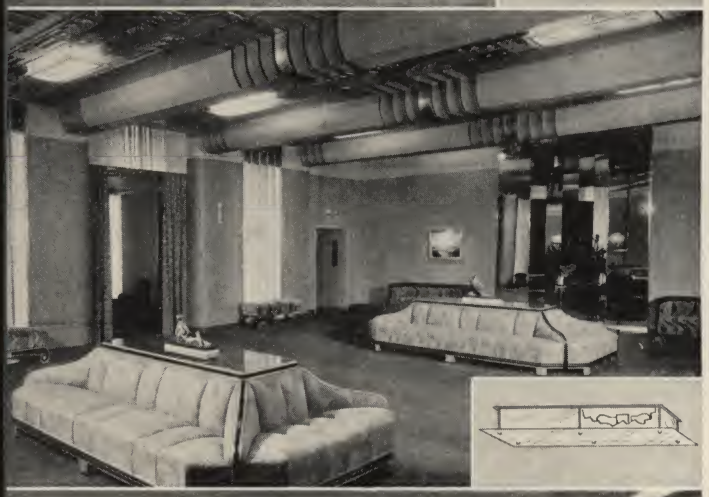
*One foot-lambert = one lumen per square foot reflected or emitted.

The Lounge and Promenade

A lounge with circular ceiling reflectors lighted by a shielding indirect bowl. An effective and efficient technique where low ceilings prohibit low-hanging decorative equipment.

Ceiling coffers may be of any shape which is architecturally in keeping. Simple and effective coffers can be constructed by a diffusing cavity equipped with a silvered-bowl lamp.

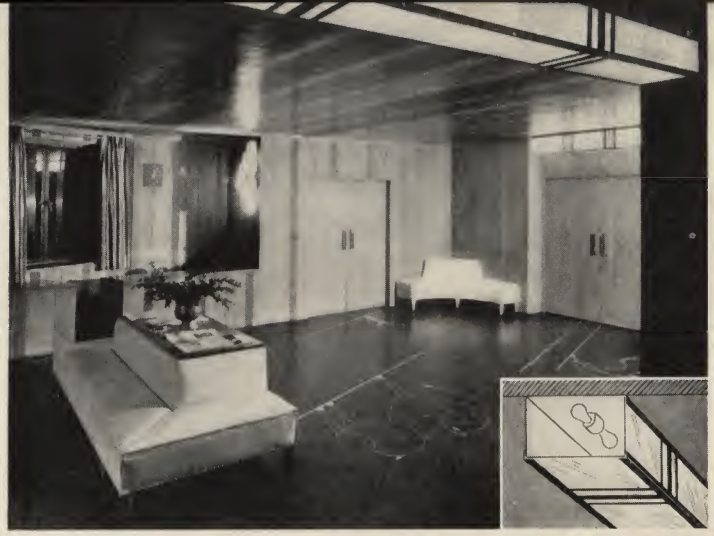
Lounge and promenade lighting should be flattering to people, mellow and tinted to eliminate sallowness and to favor make-up. Since movement is more leisurely, the surroundings and decorative features are subject to contemplation and appraisal. Color accents and purely pleasing light decoration should be employed. Here a studied application of lighting decoration is urged because of its flexibility—a new effect can be employed to extend a fresh greeting from week to week by judicious lighting arrangements and control.



Shallow luminous boxes also preserve headroom and take their place as decorative architectural elements. The number and location should obviously be regulated by lighting design principles with regard to brightness of unit and distribution of light to avoid glare and dark, gloomy corners.

A promenade with luminous cornice elements inherently a part of and enhancing the architectural plan.

Foyers

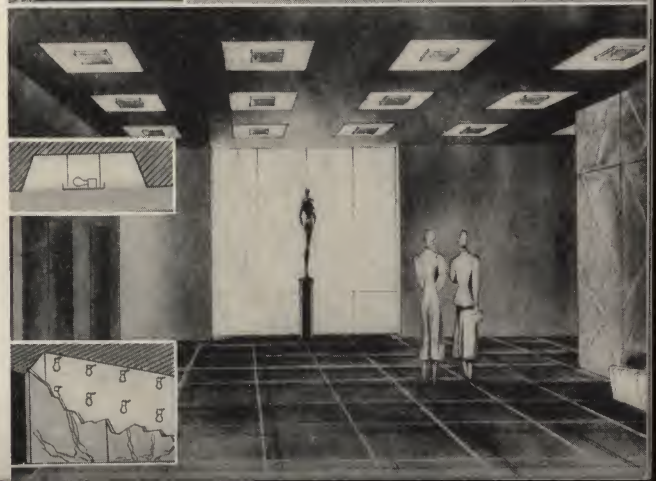


Above—The use of shallow luminous beams represents one effective solution where conventional suspended fixtures are not suitable and where modern luminous treatment is desired without altering the existing structure.

Below—A luminous band provides adequate light for the corridor; sandblasted glass is used with light sources concealed at the lower edge of the element.

A foyer serves functionally not only as a distributing center to the auditorium entrances and exits, but in many cases also functions as a lounge and waiting room. Here a lighting level of 3 to 5 footcandles serves to condition the eyes for the auditorium. This order of illumination avoids the feeling of dinginess and gloom, and is adequate for ready recognition of friends and acquaintances.

A similar treatment of a luminous edging, but employing cove lighting technique—the lighting equipment is concealed above a projecting ledge formed by a suspended ceiling.



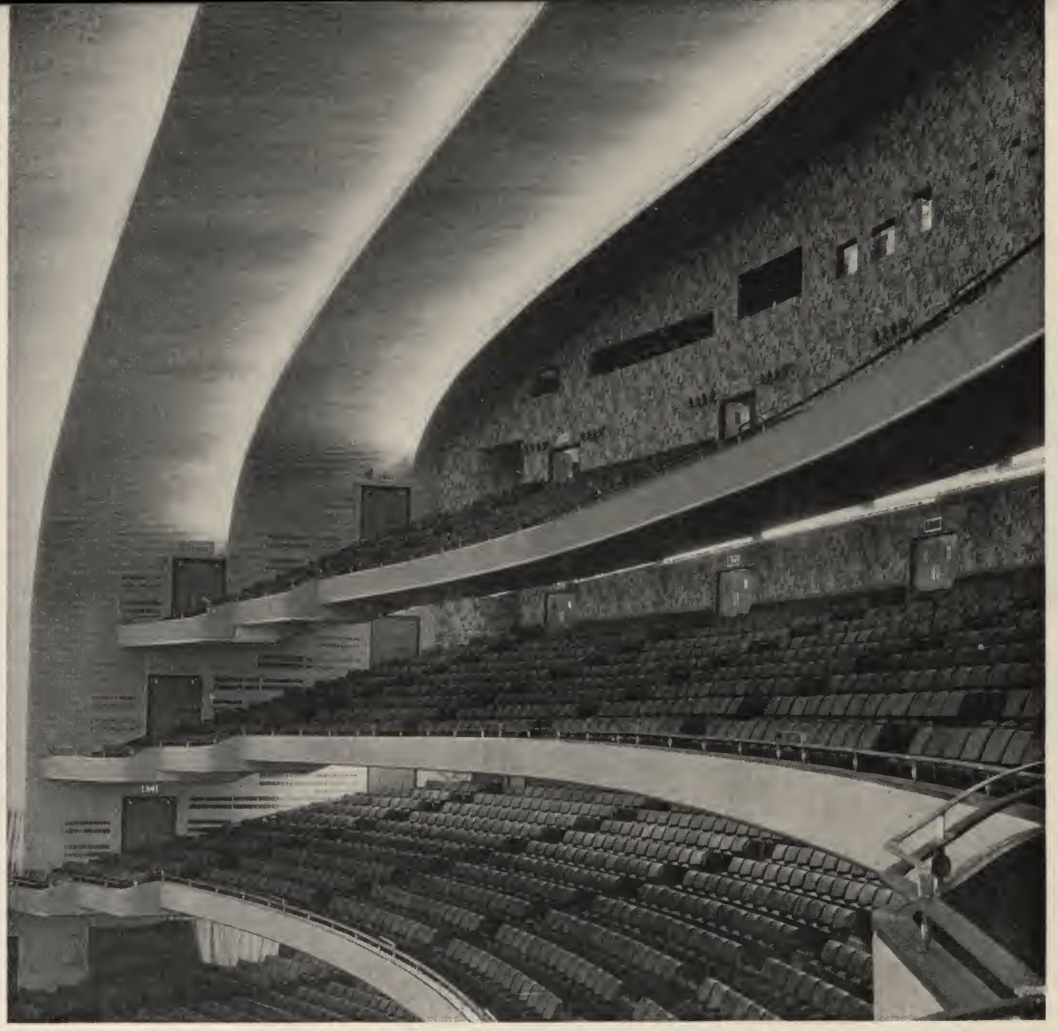
A softly luminous foyer treatment incorporating coffers. A decorative panel of illuminated marble at the end of the foyer gives distinction to this area.

Mirrors—Good lighting at mirrors always makes a favorable impression upon patrons. Light should be directed toward the subject not the mirror. For that reason the light sources must be of low brightness, comfortable and yet produce true revealing light. White, rather than tinted light, should be used so as not to produce a false impression when a person is "making up." Washrooms should be brilliantly lighted not only to impress cleanliness, but to insure it.

Stairways—Dimly lighted stairways may be a source of many annoying and expensive accidents. The example below employs Lumiline lamps following the course of the steps, insuring adequate lighting and no false steps due to confusing shadows cast by the treads.

Pictures—Art or advertising worthy of hanging is worthy of lighting for quick, easy, and clear discernment. In the example above, the flush-mounted lens units direct an even flood of light on the picture, without annoying reflections of the light source which too often veil the object and permit only a partial view.

Niches—Niches and alcoves intended as decorative accents should be emphasized by the full force of light artistry. In the case of statuary as shown below, the background should be enriched with atmospheric light of suitable color; the principal focus of interest should be highlighted with favorable directional lighting to render contour and expression in the most favorable manner.

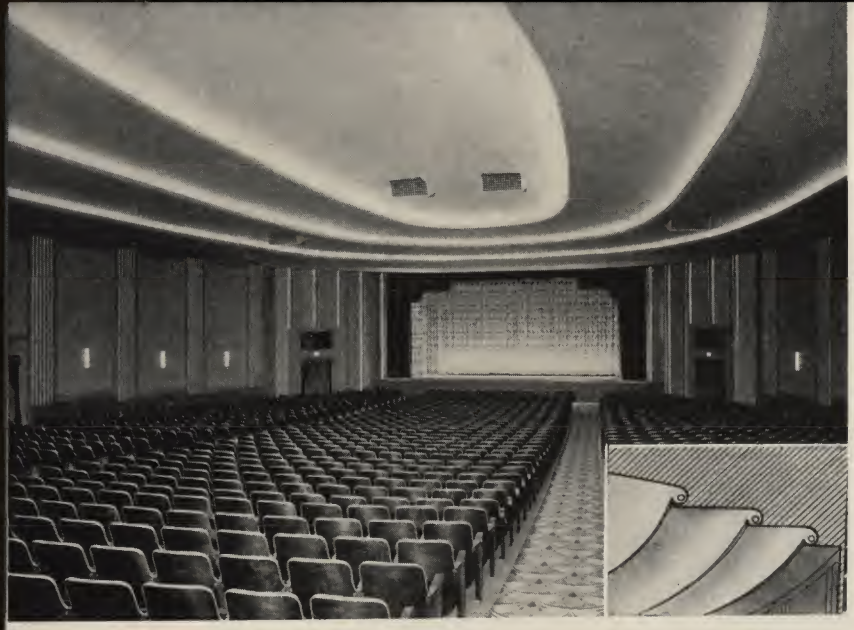


AUDITORIUMS

In the auditorium, light is indeed a versatile and useful servant. Properly placed signs direct people and answer questions before they are asked. Usher service is minimized if brightness values outside and inside the auditorium are so regulated that patrons' eyes can be accommodated at once so that seats may be found without stumbling or inconveniencing other people. Safe seeing, too, means reduced insurance losses and costs. Light discourages undue familiarity, contributes psychologically to an appreciation of the presentation; light may be cool or warm to suit the seasons or selected as to color and brightness to conform to special occasions or presentations, such as using higher brightness to aid a comedy presentation. Then, too, adequate illumination at times when people are finding or leaving seats minimizes confusion and therefore speeds up the presentation.

Illumination Levels

The illumination levels to provide depend somewhat on the character of the theatre. For opera and music hall where the audience is part of the atmosphere, illumination levels of 10 to 15 footcandles serve a splendid purpose. For movie theatres, two and preferably three levels of illumination are desirable: a bright circuit to produce as much as 5 footcandles for use during openings and closings; a medium circuit of 1 to 2 footcandles for intermissions and for special short subjects; and a graded illumination of approximately 0.1 footcandles at the front and 0.2 footcandles at the rear for use during the showing of pictures. Emergency circuits and safety facilities required by law are of course independent of the normal lighting facilities.



Auditoriums

Quality Considerations

Three considerations are foremost: (1) the brightness, whether from source or reflecting surfaces, must be low so as to be glareless; (2) sources must be so placed as to be out of the line of vision when viewing the pictures; (3) the light should be so controlled that little falls upon the screen, as this stray light reduces screen contrasts. Brightnesses up to 50 foot-lamberts are suitable in a darkened auditorium, 100-200 foot-lamberts during "breaks" in the presentation. The light from lamps must be well spread over large areas of reflecting or transmitting surfaces to meet this requirement. As to placement, the junction of ceiling and sidewalls is a first choice for comfort because it is farthest removed from one's line of vision when viewing the picture, the ceiling is second best, and the sidewall third choice; in the latter case the distribution may be poor and even low brightness is often objectionable.

Top—A modern stepped cove system employing 6-watt lamps on 12-inch centers. Amber-orange in the large ovals, yellow in the middle and white in the center.

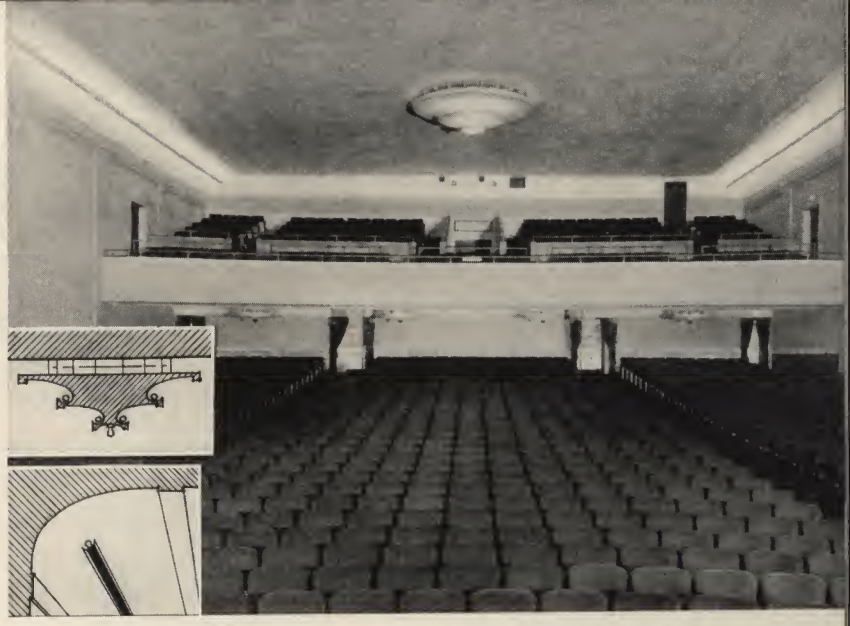
Center—A combination of an outer ceiling cove and close-mounted indirect luminaires which serve to illuminate the central ceiling area which would otherwise be dark.

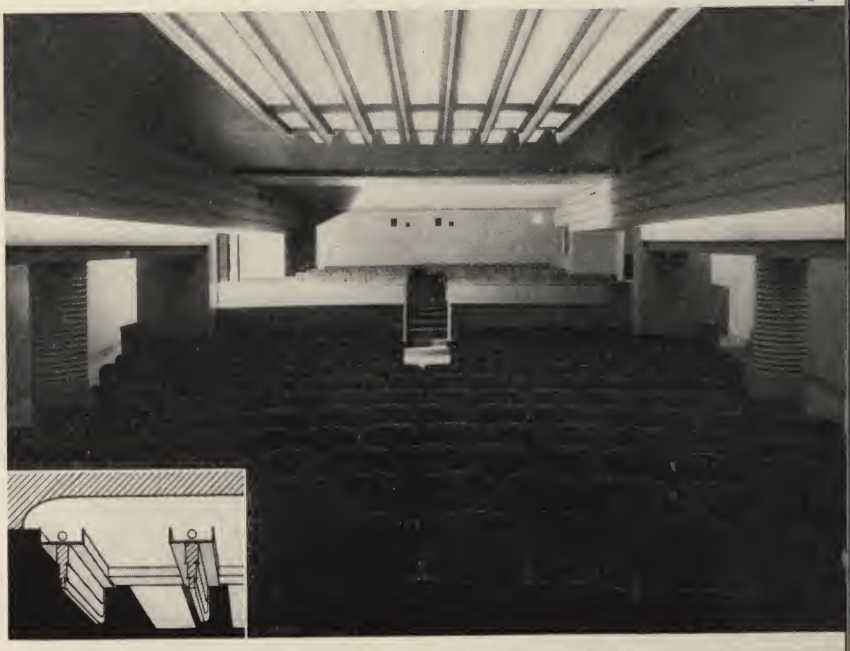
Bottom—In relatively narrow auditoriums the walls may be made luminous by the use of ceiling coves which light the sidewalls predominantly. This method when applied to larger auditoriums will require additional lighting down the center if reasonable uniformity is to be provided.

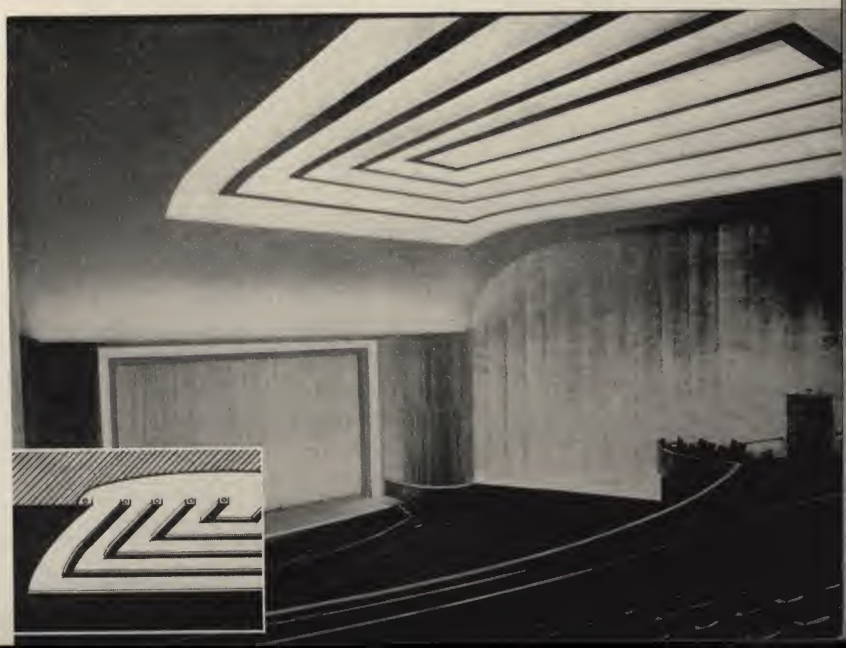
Separate Systems for Utility and Decorative Lighting

Usual types of auditorium lighting have two distinct disadvantages; first, the considerable volume of diffuse light is injurious to picture contrasts; second, where a single system of lighting serves for both utility and decoration, decoration and color are achieved usually at sacrifice of desirable seeing results. This is definitely inefficient because of the necessity of building up the volume of colored light to "seeing" levels, yet rarely is enough light provided because of economic limitations. Bearing in mind that blue is the least efficient, it is recommended that the more efficient colors such as green and amber or tints be more generally used in specific locations where higher brightness is permissible without exceeding the limit for eye comfort.

The most satisfactory solution is to provide two separate systems, one for utility or best seeing, the other for decoration alone. The former



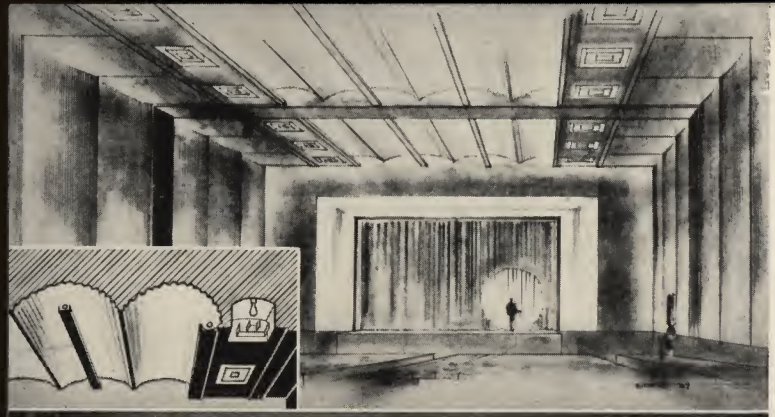


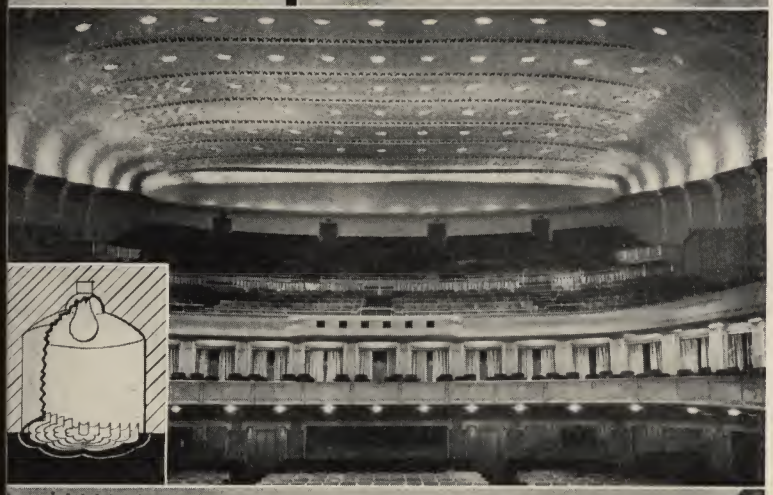


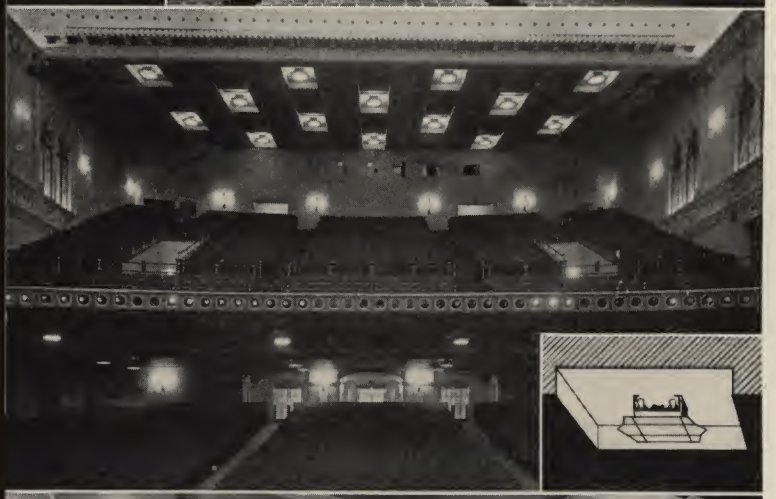
Above—The junction of ceiling and sidewalls is admirably suited to comfortable illumination. A silhouette strip is used. Added decorative effect is provided by large central multi-plane luminaires.

Center—The parallel troughs lighting a substantial portion of the ceiling area are architecturally suited to this interior. Combined with the two lower coves at the side aisles, good uniformity of light distribution is obtained throughout the seating area.

Below—Silhouette strip lighting with lamps concealed in troughs affords a simple yet striking method of lighting large surfaces to low brightness levels for comfortable vision. Color variation is simply obtained.







can then make efficient use of light of a white or light tint to favor complexions, readily distributed so as to be free from glare and without destroying screen contrasts. The supplementary decorative lighting system can then perform its function by making more effective and economical use of color.

A simple, practical solution to "light for seeing" lies in the use of downlighting, that is, from controlled lighting directed strongly to the seating area without reflection from ceiling, sidewalls and without interference with the screen. Various equipments for downlighting throughout the theatre are described on page 38; the most satisfactory system for the auditorium, in general, is one in which light is projected through small holes in the ceiling, at an angle of approximately 20° toward the front of the auditorium and with a spread of beam of approximately 40°. An elliptical reflector combination does this most efficiently, an objective lens system somewhat less efficiently. In both cases the source of light is almost completely hidden. Any system fulfilling this requirement

Top—A treatment combining decorative painted corrugated metal coves lighted by silhouette strips and utilitarian downlights with decorative louvers. Sidewalls are stepped, illumination being directed to the front of the auditorium.

Upper center—Another combination of decorative coves and louvered projector type downlights, uncolored. The downlights provide approximately 10 footcandles of illumination uniformly over the auditorium seats. They are symmetrically spaced and, because of the narrow projection angle, are quite unobtrusive.

Lower center—A combination of a large ceiling cove and decorative glass coffers. Note also the projectors installed in the front of the balcony for stage lighting effects.

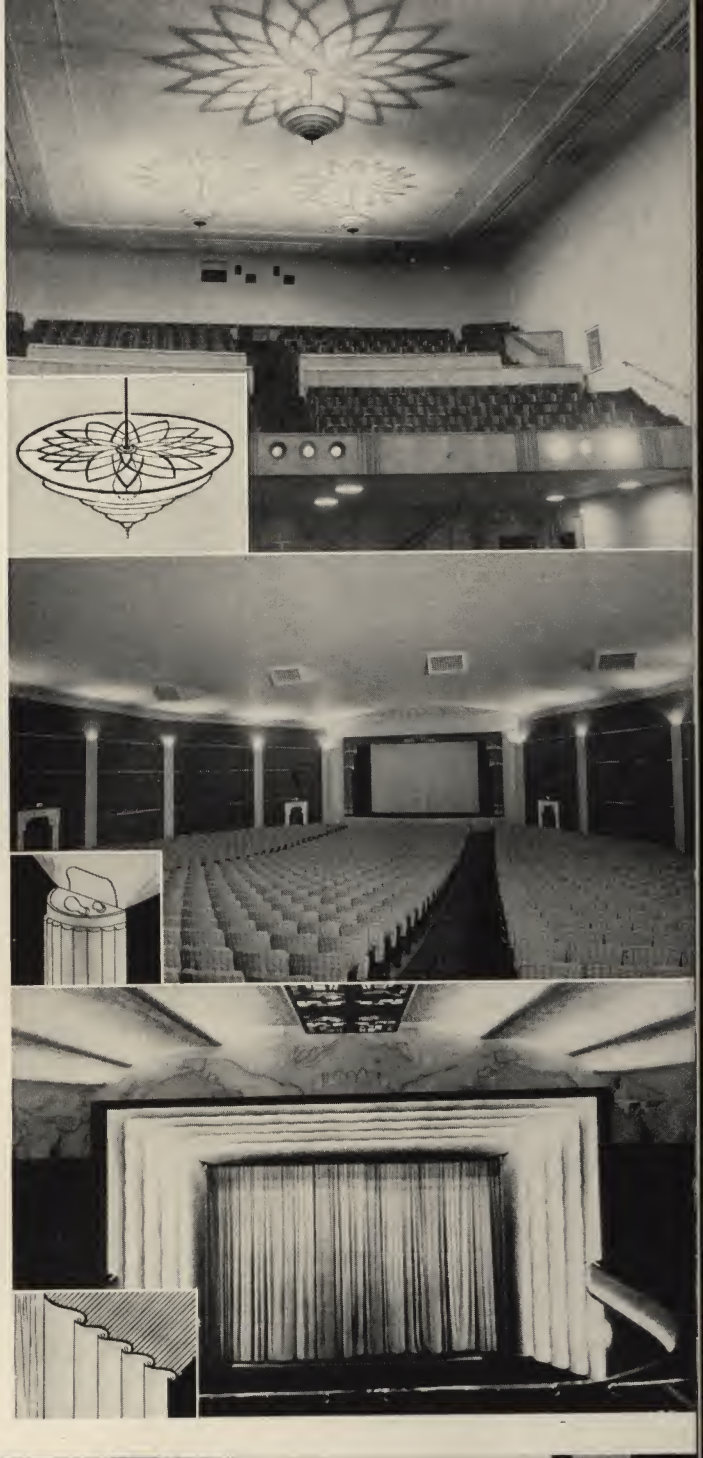
Bottom—Suspended glass panels conceal the lamps which illuminate the glass surfaces and the ceiling in this small auditorium. These are quite in keeping with the decorative aspects of the interior, yet quite different from the massive suspended luminaires that have been employed in the past.

is satisfactory. This scheme leaves ceiling and sidewalls dark, permitting decorative color from the supplementary system to be used economically.

Brightness of Screen and Surroundings

To relieve brightness contrasts between the screen and the immediate surroundings in the interest of increased eye comfort, a low brightness of approximately one foot-lambert on surfaces adjacent to the screen is recommended.

In lighting such surfaces, the source must definitely be concealed and so directed that no light spills on the screen to reduce the clarity of the picture. Any technique may be used—coves, shielded downlights or masked projectors—that will in effect border the picture screen with lighted surfaces about one-tenth of the brightness of the screen itself.



Top—This illustration exemplifies a means by which ceiling decoration and pattern can be achieved by the lighting system. Unlike moulded plaster forms, this pattern may be changed at will by changing the cut-out design placed above the lamp in the suspended luminaires.

Upper center—Complete absence of ceiling luminaires; regularly spaced wall pilasters provide a crown in which indirect equipment is placed to light the ceiling.

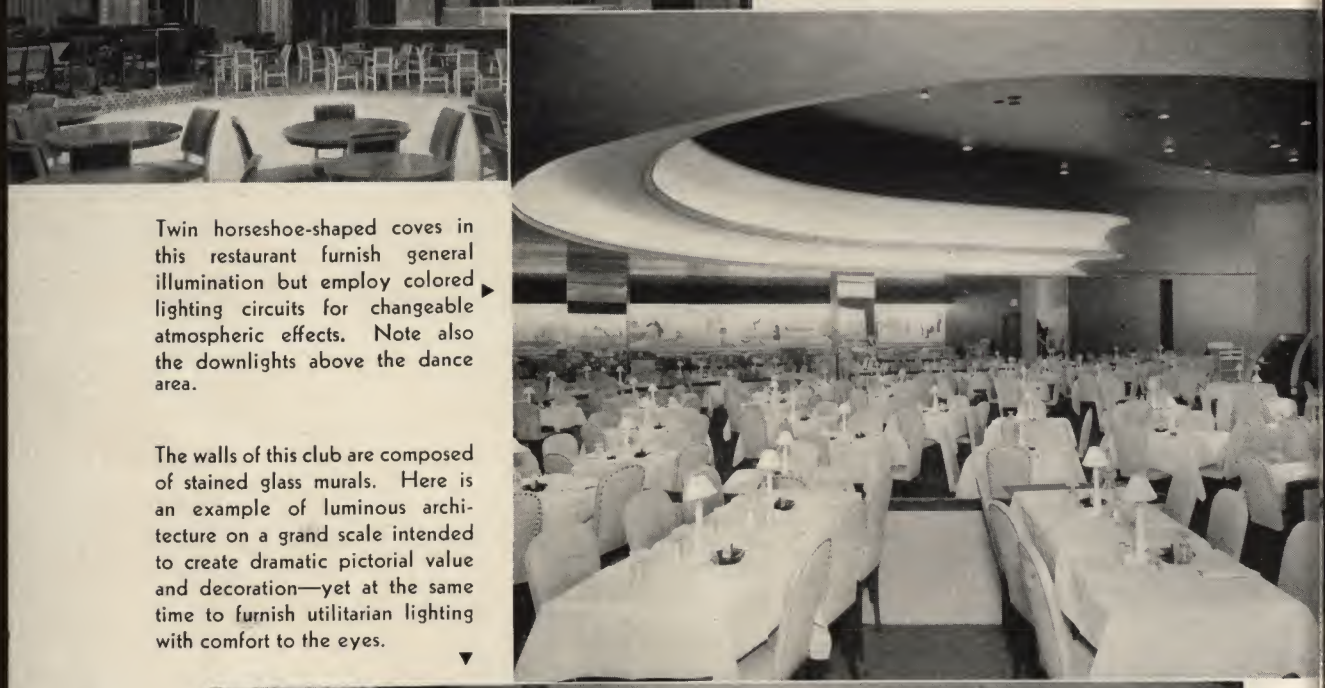
Lower center—A luminous framing for the stage in this theatre is accomplished by overlapping coves which follow the contour of the stage opening. By this method the stage can be framed by multiple lines of colored light.

Below—Two examples of under-balcony illumination—(at left) cove lighting; (at right) large luminous ceiling of low brightness.

Clubs, Restaurants and Bars

The principles, methods and forms employed in theatre lighting are equally applicable to all places where appeal and interest can be enhanced by the unique attributes of light and lighting. These illustrations show a few of the many places of amusement using to advantage unusual lighting treatments.

This large circular luminaire above the circular dance floor is really a lighting machine. In it are incorporated luminous glass in several planes for general lighting, downlights for the dance floor area, and finally projectors for lighting the wall decorations. ◀



Twin horseshoe-shaped coves in this restaurant furnish general illumination but employ colored lighting circuits for changeable atmospheric effects. Note also the downlights above the dance area. ▶

The walls of this club are composed of stained glass murals. Here is an example of luminous architecture on a grand scale intended to create dramatic pictorial value and decoration—yet at the same time to furnish utilitarian lighting with comfort to the eyes. ▼

Colorama, with its ever-changing color patterns, border this dance floor. It employs red, green, blue and clear color circuits. Three circuits of color lighting used in the stepped-up stage background are dimmer-controlled.

Even semi-permanent installations such as this ceiling of lattice work and fabric can achieve built-in design in keeping with the decorative concept. Five hundred lamps are used in the luminous scroll which provides red, blue and amber color circuits.

Two interesting light treatments of hotel bars. These applications of modern decorative lighting have given free play to the ingenuity of designers. They have created many gems in lighting decoration with striking individuality.

FACTORS INFLUENCING THE MANNER OF LIGHTING

The old way of lighting a theatre was to treat it largely as a fixturing proposition. The decorative aspect was dominant and achieved largely in the styling and ornamentation of the fixture. Tremendous chandeliers, ringed with bare lamps produced splendid examples of fixture craftsmanship but the illumination result was oftentimes harsh, garish, uncomfortable.

Today the prime concern is the illumination effect. The change was occasioned by the dominating appeal of color, its mobility and atmospheric quality. "Painting with Light" emphasizes in a phrase the newer concept. Coinciding with functional architecture there was a willingness to coordinate and integrate architectural design with lighting. This has given a fluidity to architecture, and a flexibility to lighting usage never before possible.

This change also renders inadequate the time-honored manner in which lighting systems have been classified. While it is proper to designate lighting methods as *direct* or *indirect*, these classifications do not describe the newer technique of architectural lighting. For example, a system of "direct" lighting employing flush panels of glass of large area might produce the same quality, character and oftentimes the same appearance as a similar area of "indirect" lighting making use of ceiling coves or coffers. Thus the several conventional classifications tend to merge and some other manner of grouping for purposes of discussion and analysis seems necessary. Theatre lighting projects will involve not one but perhaps all of the various methods in various combinations. For that reason the following classifications are better suited to our analysis and discussion.

1. Applied Fixtures, suspended, portable and brackets.
2. Area Lighting from Trans-illuminated Surfaces—luminous panels and beams.
3. Area Lighting from Reflecting Surfaces—coves, coffers, silhouette strips and niches.
4. Downlights and Directional Lighting.
5. Elements primarily decorative or for Advertising Display.

Obviously, a discussion of the application of these lighting methods will be limited to general characteristics and design principles; in any specific case, either of a new or a remodeling project, the exact choice and layout will depend on the interior design and how well it lends itself to the various schemes. In modernization projects where structural alterations are not contemplated, the use of applied fixtures is often the most practical solution.

BRIGHTNESS OF FIXTURES OR LUMINOUS SURFACES

This factor is concerned with eye comfort. In lobbies and corridors, where people are moving about and where the general level of illumination is high, fairly high brightness is permissible, oftentimes desirable to attract yet not be uncomfortable. In general, these brightness levels should not exceed 1000 foot-lamberts.

In the theatre auditorium, large-area, low-brightness surfaces are best because these do not force their presence upon you, are comfortable to dark-adapted eyes, and do not detract from the show itself. Brightnesses up to 50 foot-lamberts are suitable in a darkened auditorium, 100–200 foot-lamberts during the intermission.

The farther the sources of light are from the line of vision when viewing the picture, the greater the brightness permissible

for the same degree of comfort. Care must be taken, therefore, in lighting the balcony and particularly the area below the balcony. Here the low ceiling requires very low brightness units or areas. Large panel areas and coffers are suitable, but oftentimes a system of directional lighting is more practicable. In the latter method the light is directed forward either directly or indirectly from the ceiling or from reflectors and light sources shielded from view.

LIGHT DISTRIBUTION

While there is no rigid requirement for uniform lighting throughout, the best design will strive for it so that there will be no dark areas or passageways. There are fairly definite relations between spacing of lighting elements and their height above the floor to accomplish good even distribution. A general rule for theatres is that lighting elements should not be spaced farther apart than their height above the floor. Thus most auditoriums with a cove down each side should have a center cove or trough or center fixtures to build up the illumination in the center aisle and seating area. Similarly if a large cove is designed to surround the center portion of the ceiling, supplementary indirect wall urns or fixtures may be needed to build up the illumination near the sidewalls.

CEILING AND WALL FINISHES

Ceiling and wall decorations and finishes are an auxiliary to the lighting system because they not only provide a background for the lighting elements but, in the case of indirect lighting, they become a part of the lighting system itself and if light in tone contribute greatly to its efficiency. Where the ceilings and walls are too dark, the lighting units that would otherwise be comfortable when viewed against a light colored ceiling, become harsh and uncomfortable.

Particularly with indirect or semi-indirect lighting, a large part of the ceiling should be mat-surfaced and light in color, as most of the light is directed to the ceiling and from there redirected and diffused to the area below. A glossy surface should be avoided because the lamps produce undesirable streaks in the shiny surface. It is a good plan always to try out ceiling surfaces with the type of lighting equipment to be used, viewing at many angles before a final decision on the ceiling finish is made.

Low relief decorations and painted designs are oftentimes used to advantage to break up what would otherwise become unusually large and uninteresting expanses of ceiling area. Specifically, where cove lighting is employed these decorations can be made to interrupt the ceiling at the point where the light from the cove fades off perceptibly.

COLOR CIRCUITS AND CONTROL

The extent to which color is used and the degree of control for color blending and mobility also affect the manner of lighting. One shortcoming of the old fixture era was the limitation in the effective use of color. For good results large luminous surfaces are needed and structural facilities must be adequate for the additional reflectors and wiring required. Where color application is planned with applied fixtures, troughs and luminous beams may be employed. However, coves and coffers or luminous glass elements are most generally employed

for the best effect of colored lighting. In some instances, concentrating "downlights" have been employed for general lighting of the auditorium which leaves the ceiling and wall areas comparatively dark. These areas are then free for supplementary colored decorative lighting.

WIRING AND LIGHTING CONTROL

The underlying fundamental to flexibility and effective usage of light is the wiring and control facilities. Provision should be made in the reflecting equipment and in the wiring so that the next larger lamp size than planned for initial installation may be used at any future time. This can be accomplished at little increase in cost at the time of the installation and will permit increased illumination without additional equipment expense should future circumstances require it. By providing adequate circuits, greater flexibility is assured.

MAINTENANCE

This is a vital factor in the choice of a lighting system. Allowance should be made in the original design for normal depreciation between cleaning periods and lamp renewals, but special consideration should be given to the choice of equipment and the features of design to obviate unduly high depreciation or high maintenance costs. Dust and dirt on lamps and reflecting surfaces may quickly cut down initial efficiency 50 per cent, which is equivalent to wasting half the money paid for electricity. If such a condition prevails the constantly accumulating losses will shortly offset higher initial costs of equipment and facilities which prevent such rapid depreciation. Lighting maintenance in theatres is oftentimes neglected because in many locations it is difficult to reach the lamps and equipment for frequent cleaning. Where lamps are in out-of-the-way places —difficult to reach, group replacement of all lamps at approximately two-thirds life will assure minimum cost of maintenance.

EMERGENCY LIGHTING

Emergency lighting is usually required by law. If for any reason electrical service is cut off, there should be sufficient light to enable patrons to find their way about, and out, if necessary. Promenades, stairways, corridors, foyers, lobbies, etc., which are normally kept lighted during the performance should have emergency lighting. All exit signs should be on the emergency circuits.

Exit signs are required over every point of egress. The letters should be large enough to be legible from any distance from which viewed; some states require a minimum of 8 inches in height. Red is generally the preferred color, but green or white are sometimes used where the law permits. Green seems to be a logical color because of its association with safety.

The State of Pennsylvania prescribes that the emergency lighting system be capable of producing a minimum of 0.5 footcandles on the floor of promenades, stairways, corridors, foyers, lobbies, etc., and a minimum of 0.25 footcandles on the floor of the auditorium for a period of one and one-half hours. Local requirements of course vary. Some cities, for example, require that where two separate street mains are available, two separate and distinct services should be installed, one of sufficient capacity to supply current for the entire equipment of the theatre, the other service at least sufficient to supply current for all emergency lights. Other methods employ battery systems, always kept fully charged by a motor-generator or trickle-charger set.

LIGHTING FIXTURES

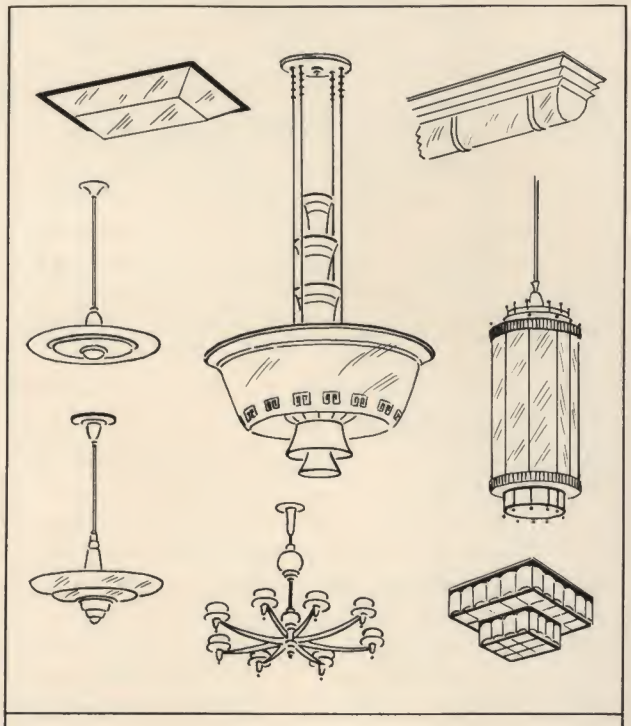
Attached "fixtures" will always have a prominent place in lighting, either as the principal system, or in conjunction with built-in elements. The forms and styling have undergone considerable change to meet the more functional requirements as to brightness, amount, control, and distribution of light.

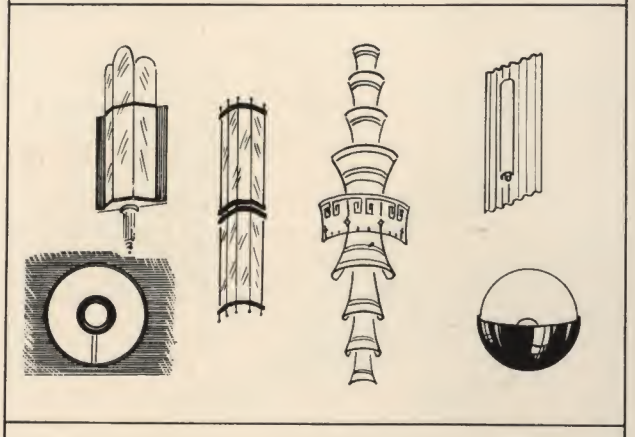
Suspended Fixtures—The entire range from direct to totally-indirect fixtures is applicable. The principal requirement is that the lighted fixtures will be comfortable under all conditions, and that they function adequately with respect to the amount and distribution of light. Brightness of lamps or luminous fixtures within normal viewing angles should not exceed 200 foot-lamberts for auditoriums and lounges. Brightnesses up to 1000 or 2000 foot-lamberts may be acceptable for lobbies and similar areas.

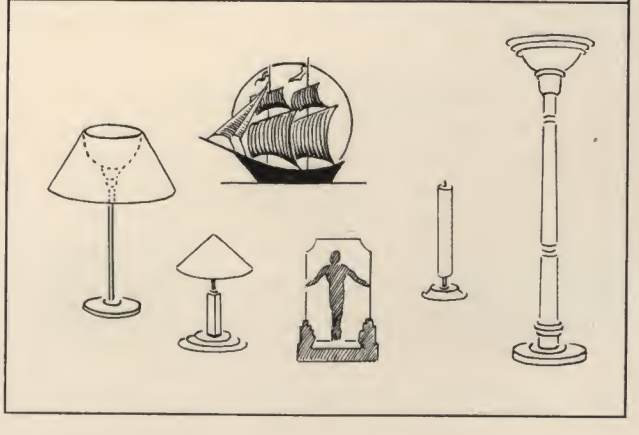
Many modern interiors have employed continuous suspended trough equipment, either totally-indirect or with luminous decorative panels. Such equipment may also incorporate lens or louver control for direct downlighting.

Wall Brackets and Urns—These are essentially decorative to produce an accent of light and color on a wall surface, and should be of low brightness because of their location. Indirect wall pockets, or urns set atop pedestals or pilasters, may effectively supplement other methods of lighting to increase the illumination level near the walls. Lumiline lamps are for both utility lighting and decorative effect. The brightness of the 30-watt white is approximately 450 foot-lamberts; the 40- and 60- about 900 foot-lamberts. Colors range much lower in brightness.

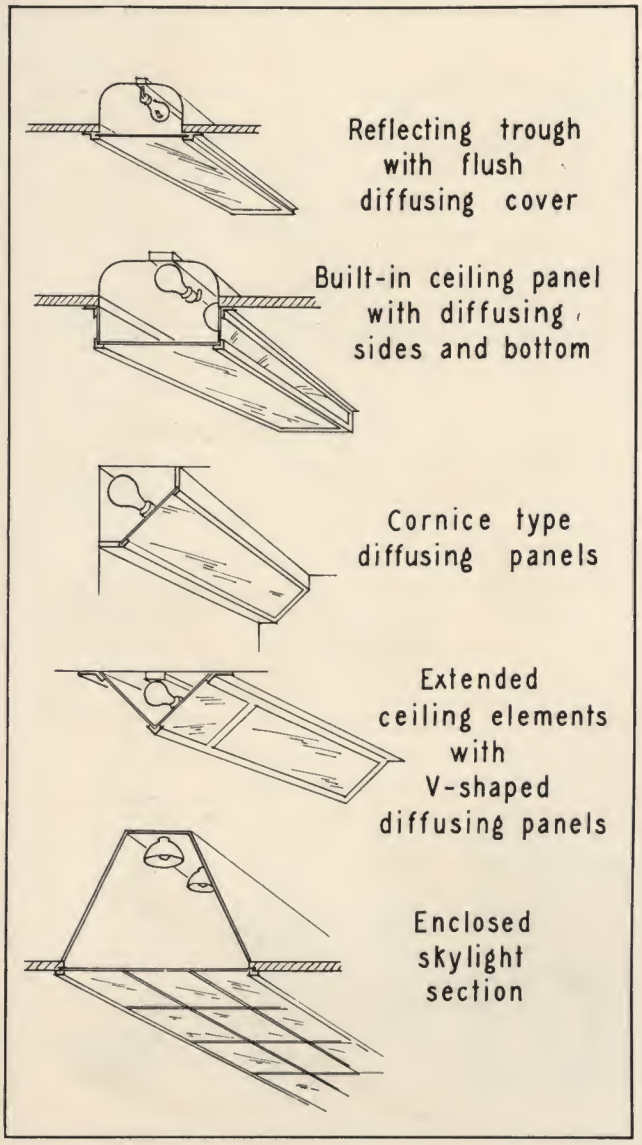
Portable Luminaires and Lighted Ornaments—For theatre purposes portable lamps and lighted ornaments, whether they be luminous decorative glassware, silhouette models, or what not, serve the same decorative purpose. Such uses of light admit no technical implications beyond the fact that the effect be pleasing and satisfying.

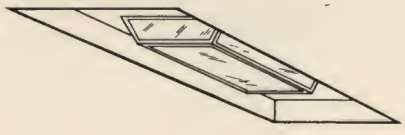






LUMINOUS ELEMENTS





Luminous element coffers
(May be any shape including circular)

Luminous panels and projecting elements are important architectural forms, adaptable to many conditions and manner of decoration. They offer a choice of many translucent materials varying in texture and appearance, both lighted and unlighted; they can be made to harmonize with surroundings both in physical scale and decorative interest. From the standpoint of illumination, they present a means of obtaining large area, low brightness sources, with ample dimension to accommodate lamps and wiring for color circuits. Uniformly luminous elements faced with cased-opal glass have been most widely used, but often more subtle and charming results are obtained by the use of graded brightness to produce highlights or sparkle.

The exact character of element employed for any location will depend on architectural design, being regulated by the space or recess depth available and by structural requirements. Many types of both recessed and projecting elements are now listed in manufacturers' catalogs.

Brightness Distribution—For uniformly lighted areas using good diffusing materials —cased-opal glass, plastic sheets, or translucent marbles—the spacing of lamps should not exceed 1½ times the distance of the filament from the material. For less diffusing materials, the spacing must be a smaller ratio, or the lamps may be placed in such a position with respect to the translucent material that the lamps are shielded. In general, varying brightness unless deliberately and skillfully planned is apt to look ragged.

The brightness of interior elements may range from 75 to 1000 foot-lamberts depending on (a) the amount of surrounding illumination, (b) brightness contrast with adjacent surfaces, (c) position and size of elements, (d) casual or prolonged viewing.

COVES AND COFFERS

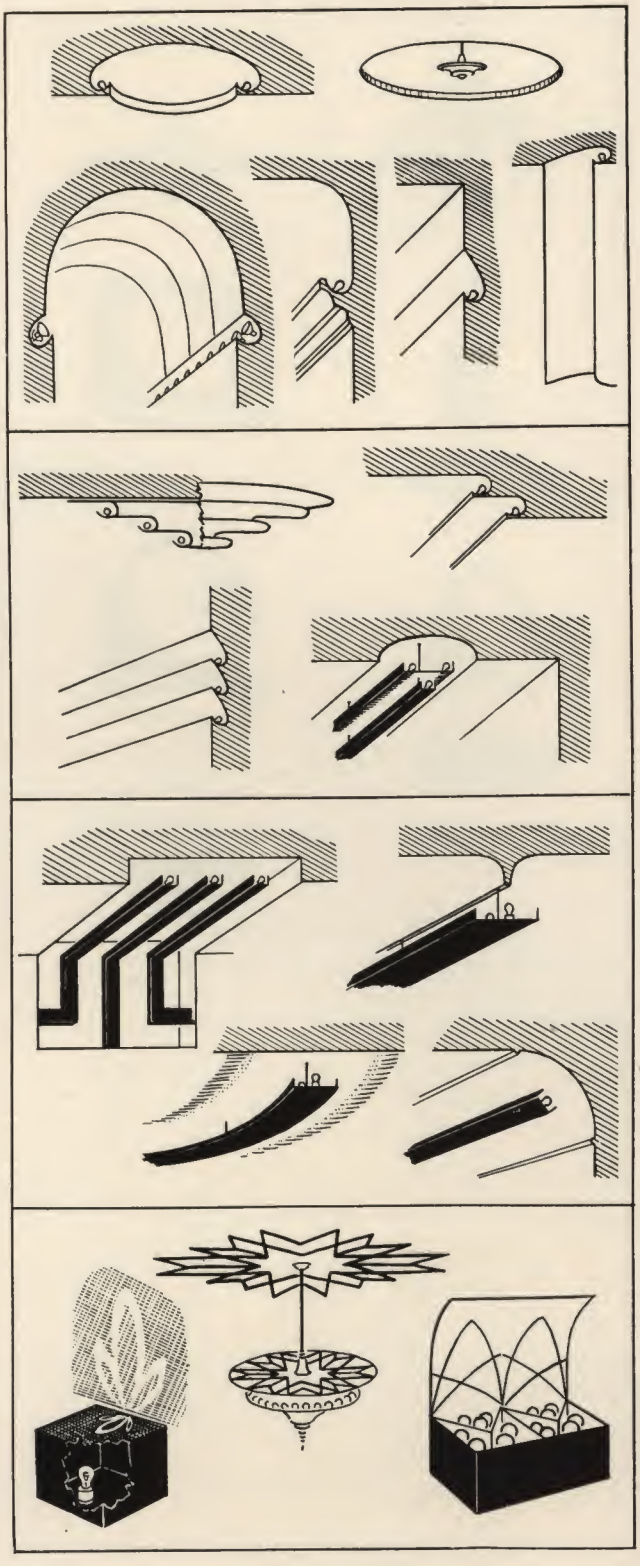
These architectural lighting schemes differ from so-called luminous elements in that the surfaces become luminous by reflection, rather than by interposing a translucent material. The most common method is to conceal lamps in cornices or around the edges of recesses. Other methods employ silhouette strips or artificial beams which approach in technique the use of suspended troughs, urns or built-on ledges. The principal influence in the choice of method is again the architectural design, in which full consideration must be given the space and location of lamps, reflectors and wiring to provide logical efficiency and acceptable light distribution or coverage over the reflecting surfaces.

Coves and coffers are particularly adapted to mobile color and painting with light. Bare inside-frosted or natural-colored bulbs in white trough reflectors may be used to illuminate surfaces up to four or five feet wide; for longer throws and greater efficiency individual reflectors should be used, preferably with cover glasses to facilitate maintenance.

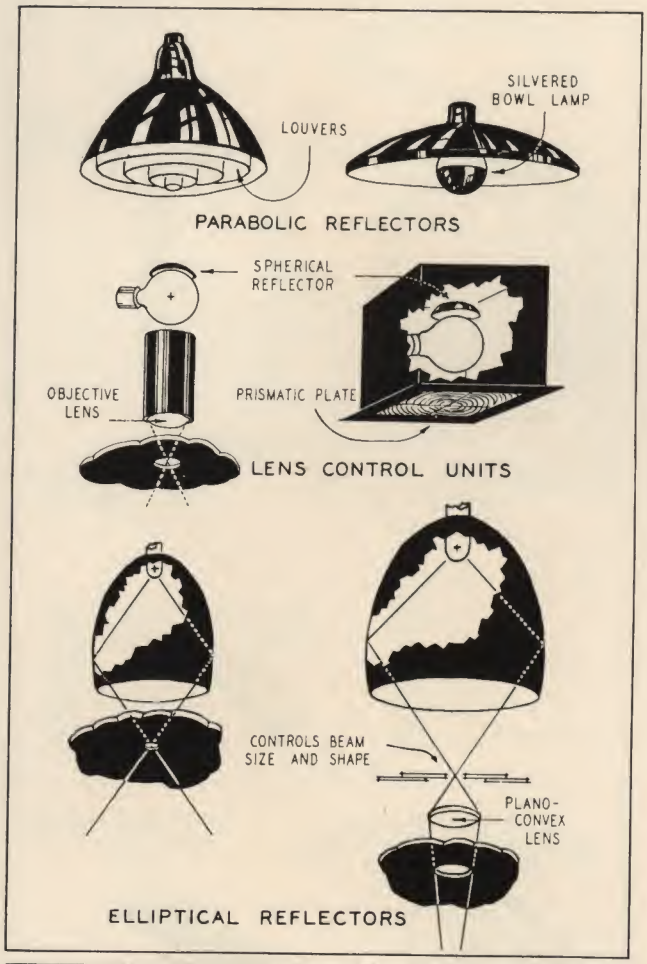
Multi-plane or overlapping coves offer a means of superposing colors in contrasting patterns without dilution or mixing. Reflecting surfaces can be given unusual decorative value by using corrugations or flutes in simple lines or geometric figures; by lighting from two directions in different colors, the surfaces take on a colorful textured appearance.

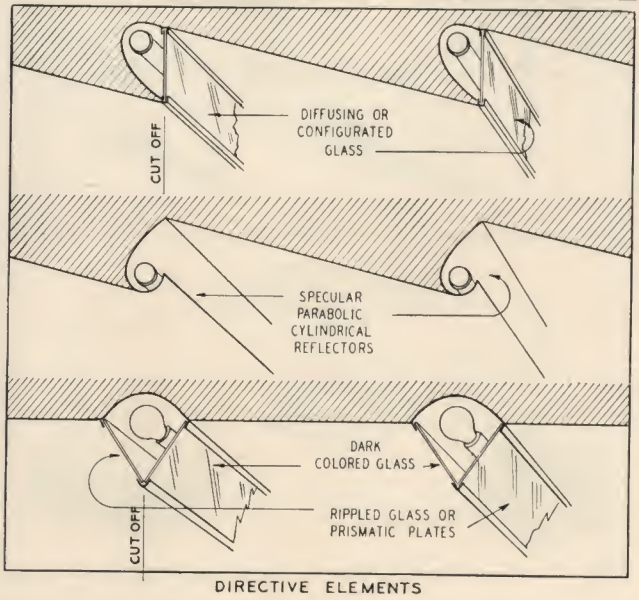
Mat-finished reflecting surfaces in light, neutral tones are important, for use with the usual types of indirect units. Metallized surfaces or glossy paints are not generally desirable.

Shadow and shadow patterns, particularly those designed for pleasing color effects, are both interesting and intriguing. The term "Colorama" was coined to convey the endless variety in decorative effect possible of achievement by projected light patterns on wall and ceiling areas.



DOWNLIGHTS AND DIRECTIONAL LIGHTING





DIRECTIVE ELEMENTS

The term "downlights" is used to identify concentrating direct lighting equipments available in many different forms for lighting marquee soffits, posters, auditoriums, and other interiors. They localize the illumination or direct it to specific areas from concealed or unnoticeable sources.

Parabolic Reflectors

Parabolic reflectors with louvers or silvered-bowl lamps provide a simple means of downlighting where some source brightness is permissible. The louvers, made in a variety of forms—concentric rings, squares, and in decorative geometric designs—shield the lamp from view, eliminate spill light, and aid in providing the desired degree of concentration. They vary widely in performance providing spreads from 10–60° and with efficiencies of 25 to 60 per cent. Translucent louvers may also be used.

Control Lenses

Prismatic glass plates, plano-convex and Fresnel lenses set flush in ceiling mountings permit a wide range of light distribution from quite concentrating to fairly widespread; also asymmetric or angular distribution may be obtained depending upon the focal relations between the lamp and control lens. The output will vary between 30 and 60 per cent depending on the distribution. An objective lens system which projects the light through a small opening is especially suited to auditorium illumination.

Elliptical Reflectors

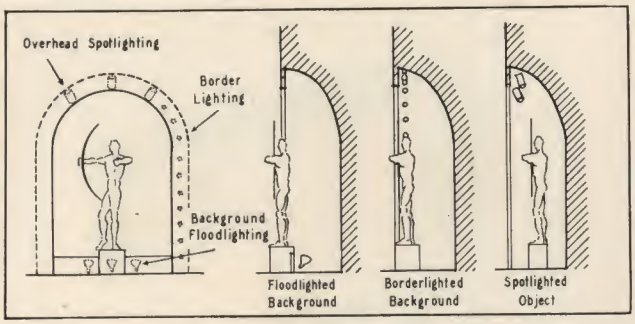
An efficient combination for distribution over a limited area from small ceiling openings. The equipment is installed so that the secondary focus or crossed lens rays fall at approximately the ceiling opening as illustrated.

Directive Elements

Control of brightness may also be obtained by directional lighting as represented by the accompanying sketches. Such methods are especially applicable to under-balcony lighting.

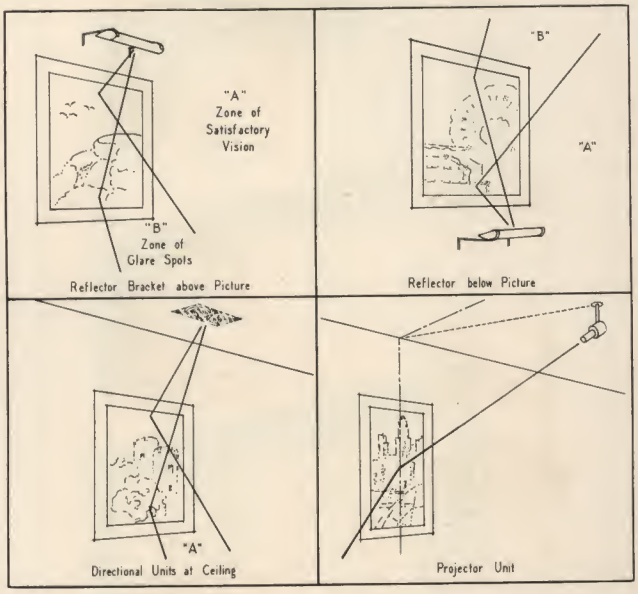
NICHES

These serve essentially as interest points and should have five to ten times the illumination of adjacent surfaces. Silhouettes are desired for certain displays, in others the background may best be employed for color and atmosphere with the object sharply spotlighted in white light. In other instances, strong directional light in various colors will create striking color shadows.



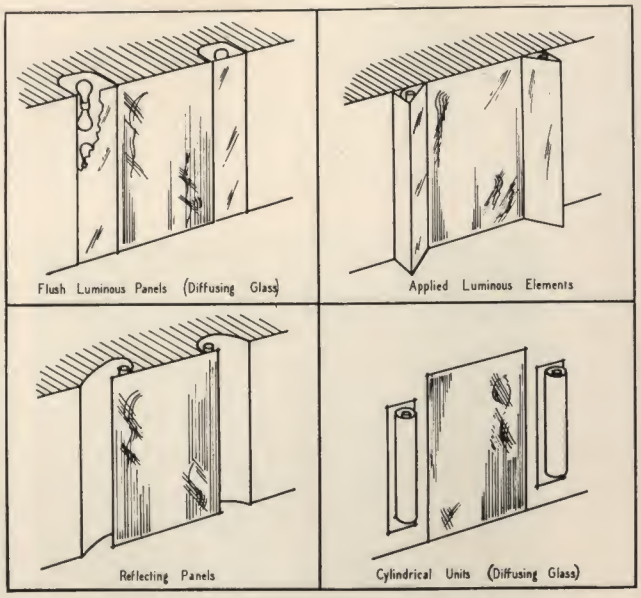
PICTURES

Good paintings and wall hangings deserve good lighting. The principal problem is to get an even distribution of light over the display, at the same time avoiding reflections from glossy surfaces or glass facing. With overhead lighting from either bracket type or lens plate units, a concentrating distribution is necessary both for uniform coverage and to avoid reflections; the units should be so directed that the highest candlepower falls on the lower quarter of the picture. Lighting from below inherently avoids glaring reflections, but is not practicable in some locations, particularly where the units are within reach and likely to be disturbed; excellent, however, where equipment may be built into ledges, wall cases, or table tops. Conventional floodlighting equipment may oftentimes be employed where it can be concealed.

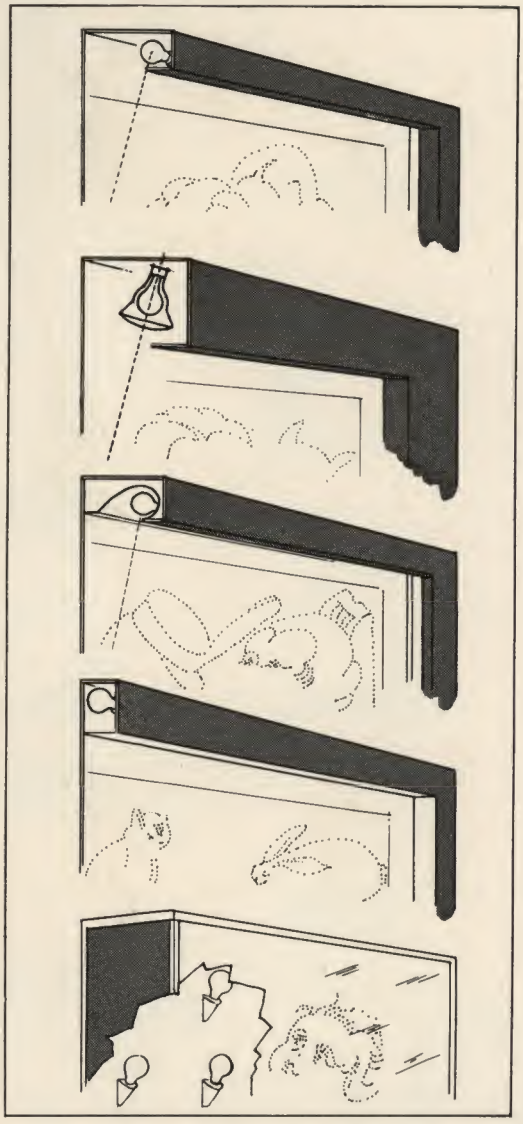


MIRRORS

The requirement is merely that of low brightness diffuse sources—panels, luminous recesses, attached fixtures or portable units, so placed as to direct the light to the patron or observer. Where space and method permit, a second circuit using Daylight lamps to be used for make-up during daylight hours will be appreciated.



LOBBY AND DISPLAY SIGNS



The value of lighted posters is appreciated by every enterprising showman. In general, posters should be 10 times as bright as their surroundings to stand out properly.

When mounted flat on wall surfaces they can be lighted by the same methods as pictures or wall hangings illustrated on the preceding page. The modern theatre, however, is giving greater attention to display facilities by building in permanent poster treatments. These must be designed with full knowledge of the requirements if the best lighting result is to be obtained.

Lamps in recesses at the top of the posters should if possible project out a distance of one-fifth the poster height. Concentrating reflectors of trough type employing the parabolic-cylindrical contour, or individual reflectors are necessary for good coverage of light when the units are mounted closely to the surface to be lighted.

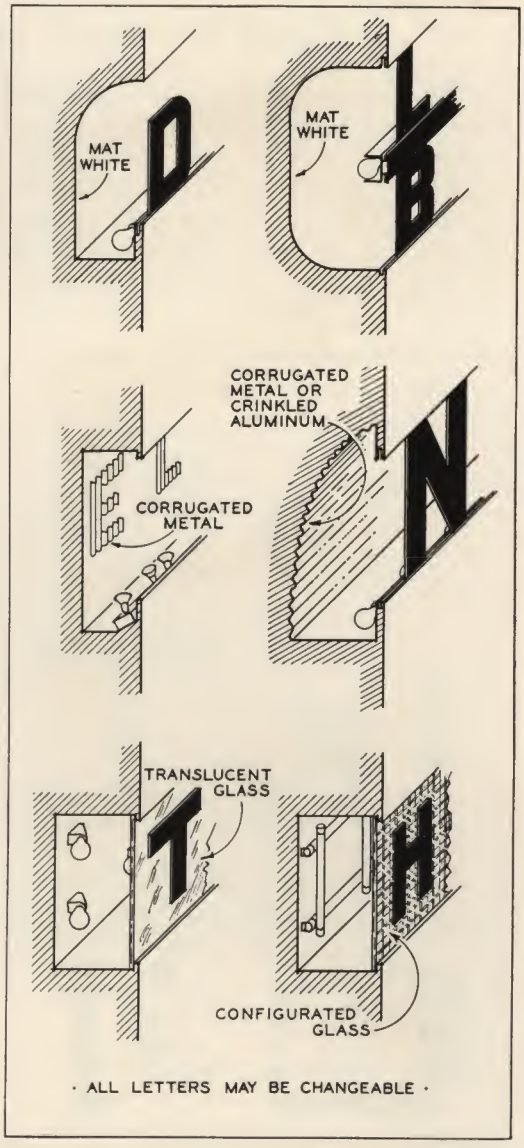
Transparencies may be lighted by lamps uniformly spaced behind the transparency (lamp spacing 1½ times the distance of lamp to glass) or they may be lighted by the wedge-type construction illustrated on page 42.

Portable posters may be lighted by carefully masked spotlights so located that people can neither face the beam nor walk through it.

The space over lobby doorways is a most important location to bulletin coming attractions. This space may be a simple ledge or cove to light the upper wall against which cut-out silhouette letters and designs may be shown.

The light-box or recessed cavity is perhaps of greater significance because of its adaptability to various installation conditions. The sketches opposite show several practical arrangements of lamps with reference to cavity form and method of mounting changeable letter copy.

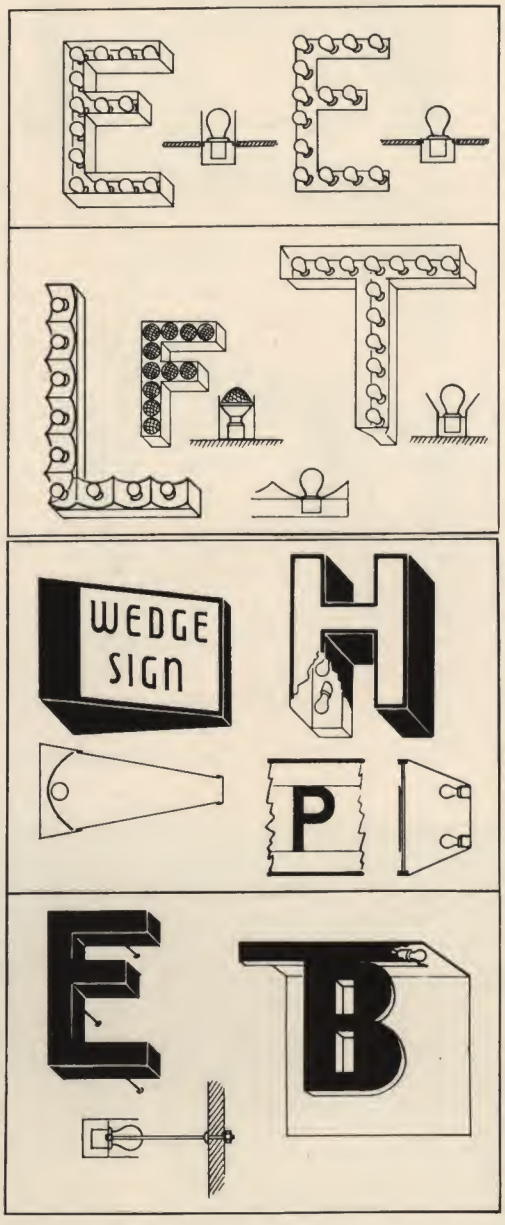
The ticket booth is a logical location for attention-compelling display. It is the theatre's first direct point of contact with the public. It should be attractive and, obviously, it should be easy to find. Here again, light can provide attention value as well as interest and beauty. Luminous panels built into the sides of the booth are particularly effective in attracting attention if maintained at a high brightness, and they serve as a ready-made background for silhouette copy, permanent or changeable, giving prices or further details of the performance.



ESSENTIALS OF SIGN DESIGN

Effective electrical advertising connotes, fundamentally, attention value and remembrance value. To achieve these qualities requires, first of all, dominance in size or brightness with good legibility. Secondly, it requires individuality—that is, intriguing interest achieved by motion, color and changeability. Good design will recognize these principles.

The priceless ingredient of a sign is creative design skill; the technical essentials of sign design are the factors which make for legibility, for smoothness, for changeability, and determine the type of lighted letter best adapted to the specific conditions of location, construction and range of viewing. A brief summary of several classes of sign construction follows:



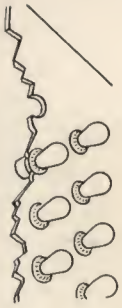
Exposed Lamp Signs—The principal attributes are (1) brightness and sparkle (2) color, (3) motion, all of which can be easily changed as surroundings or competitive display dictates. They can be very simple in construction, adaptable therefore to temporary use for current features.

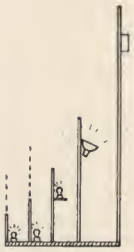
The *reflector sign*, either with individual lamp reflectors or durable, polished metal troughs or inserts, multiplies the brilliance and range for the same wattage consumed. Though somewhat more expensive initially, this is soon offset in permanent installations by the increased advertising effectiveness.

Enclosed Lamp Signs—Generally most effective for short viewing distances up to 1000 feet. Modern block letters give dominance and are adaptable to contemporary architectural forms. For a simple marker the wedge-type construction offers the utmost in simplicity of construction, efficiency of light utilization, and low cost.

Silhouette Signs—This type capitalizes on the attention-value of large luminous areas against which the advertising message is displayed. By combination with exposed lamps on the face of the letters, and by provision for color circuits, this type offers color, motion and individuality in a high degree.

SIZE AND LEGIBILITY	SMOOTHNESS OR UNIFORMITY	BRIGHTNESS
Legibility is a prime requisite of all forms of written advertising. Because of variations in viewing distances, letters or designs must be carefully planned as to size, spacing and brightness of the adjacent elements or strokes.	Smoothness or uniformity in lighted appearance aids legibility. When one portion of a letter or pattern is brighter than another or where a luminous background is spotty, the effect of irradiation tends to blur or obliterate detail.	Bright signs compel attention and stand out from competing displays. Displays are influenced by street lighting, window lighting, and other signs. In brighter districts they must be brighter than similar displays located in darker locations.
Range of Effectiveness 250 Feet to Several Miles Letter Height (in feet) = $\frac{\text{Max. Viewing Distance (ft.)}}{500}$ Double this letter height is preferable. Block letters are more legible than script or special forms though the latter may possess more individuality. Wide extended letters are more legible than narrow condensed ones. Channel letters serve to keep stray light from backgrounds, to improve smoothness and legibility at wide angles and close viewing.	For smoothness, the spots of light, which vary in size with wattage, viewing distance, and surrounding brightness, should be tangent to each other at closest distance at which sign is to be viewed. For very close viewing, lamp bulbs should be approximately ¼" apart. Spacing of Lamps (in feet) = $\frac{\text{Min. Viewing Distance (ft.)}}{1000}$ To estimate number of lamps, multiply $\frac{\text{Letter Height}}{\text{Lamp Spacing}} \times$ Number of Letters × 2.5	Depends on surroundings—the brighter the district the larger the lamp. Vacuum-type sign lamps are available in 6, 10, 25 and 40 watts, clear and colored for outdoor exposed lamp signs. Also 25- and 50-watt in clear daylight bulbs. Reflecting signs produce two to four times the candlepower brightness within a 90-degree viewing angle as the same wattage with conventional backgrounds.
Range of Effectiveness Up to 1000 Feet Letter Height (in feet) = $\frac{\text{Max. Viewing Distance (ft.)}}{300}$ Again the width and proportions of the letter stroke influence legibility distance. For greatest legibility of silhouette letters, width of stroke should be about one-seventh of the letter height. Appearance, however, may dictate other proportions.	The lamp spacing (inches) should not exceed the distance of the filament from the diffusing translucent surface. This provides a factor of safety in case of burned-out lamps. Maximum lamp spacing for uniformity with all lamps burning is 1½ times distance of lamp filament to translucent surface.	**Recommended Wattage Per Square Foot of Translucent Area** Bright Districts, Large Cities . 125-200 Luminous Letters, 60-75 Luminous Background Main Streets, Average Cities 75-125 40-60 Business Districts, Small Cities . . . 50-75 25-40
Range of Effectiveness Up to 1000 Feet Letter Height (in feet) = $\frac{\text{Max. Viewing Distance (ft.)}}{350}$ Letters twice this size are recommended for greater effectiveness. For greatest legibility letter stroke width should be about one-seventh of the letter height. Depth of letter stroke influences distance apart for legibility at side angles.	Lamp spacing (inches) should not exceed 1½ times the distance of the lamp filament from the reflecting background.	**Recommended Wattage Per Square Foot of Luminous Background** Bright Districts, Large Cities . . . . . 60-75 Main Streets, Average Cities . . . . . 40-60 Business Districts, Small Cities . . . 25-40





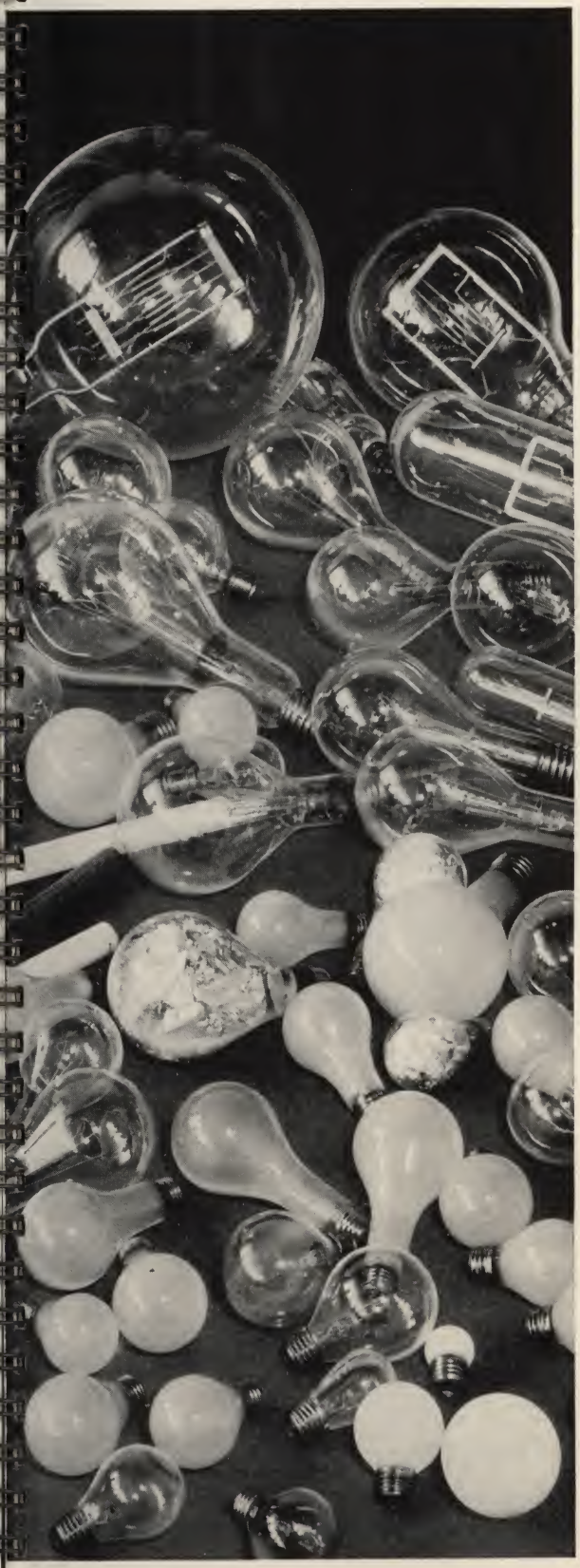
Temporary Displays

Lamp Signs—Holes may be drilled 2 to 3 inches apart in prestwood or other suitable background to form the letter or patterns. Pre-wired sockets, spaced 3 to 4 inches apart, can then be inserted in the holes and held in place by rings, rubber washers or by the lamps themselves.

Multi-Plane Scenes—Multi-plane displays or signs in adding the third dimension provide unusual posterized effects. Lamps are placed close to concealing planes and light the background; two or more planes may be used to give the perspective and depth required.

Shadow Screens—Shadow screens are made by placing colored lamps (spotlights or floodlights in larger displays) several feet behind a translucent glass, tracing paper, or cloth. Lamp positions should not show through the screen. Objects placed between the screen and the sources will produce multiple-colored shadows. If the objects are suspended and free to turn or sway in the currents of air, interesting motion and varying color patterns occur.

Fluorescent Effects—Such displays require dark surroundings. For murals or posters of the type illustrated below, a second scene or message in fluorescent inks is overprinted on the non-fluorescent. The first view shows the appearance under ordinary white light, the second the picture that appears when switched to ultraviolet sources. The newer forms of mercury sources fitted with red-purple filters to absorb the visible light are well adapted to this application.



MAZDA LAMPS

Each year about 15 million incandescent lamps are used by theatres. This represents a lighting cost for lamps and electrical energy of perhaps 25 million dollars annually, the lamp cost being about one tenth of the cost of current to operate them. The only reason for buying lamps is to get light, and by far the most important consideration in the purchase of lamps is their maintained efficiency—that is, the ability of the lamps to convert electrical energy into light.

Getting good light at lowest cost resolves itself into using lamps of highest efficiency for any particular application. The price of a lamp is of minor consideration in the over-all cost of producing light; similarly lamp life by itself is no criterion of value since lamps may be designed for any life. The qualities of a good lamp besides efficiency and related life are (1) uniform performance (2) accurate rating, (3) freedom from defects, and (4) strength.

For dependable and satisfactory service lamps should be properly used; that is, be of voltage rating corresponding to socket voltage, and be of a type and design suited to the given service.

Several hundred types, sizes, and finishes of MAZDA lamps are regularly available for theatre use. They range in size from the small 6-watt lamp used primarily for sign and decorative service to the 10,000-watt lamp used in motion picture studio lighting.

MAZDA lamps are adaptable to efficient utilization of light because of effective control by reflectors of proper contour. They offer flexibility as to color and brightness changes at will, and are adaptable to installations in restricted space and for various positions of burning.

MAZDA LAMP QUALITY AND ECONOMY

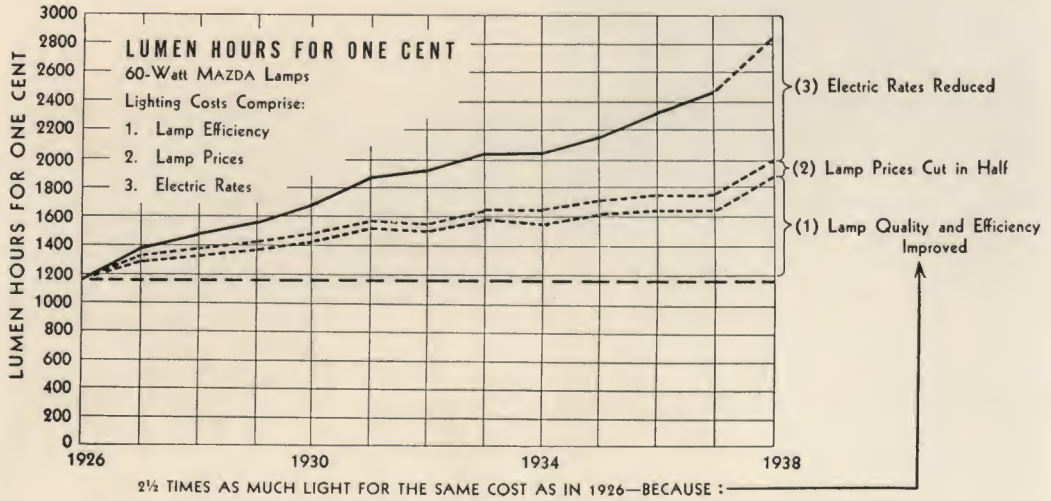
Price and Efficiency—Lamp quality and efficiency have proved many times more important in reducing over-all lighting costs than lower lamp prices. This is illustrated in the chart below which shows the record of the 60-watt MAZDA lamp over the past decade in which the effect of lamp price reduction may be compared with the factor of improved quality and efficiency in relation to the amount of light produced for one cent. A cheap lamp, unless both high efficiency and durability are assured, will actually increase the cost of light.

Operating Voltage—When lamps are burned under their rated voltage useful electrical energy is wasted. Undervoltage burning has the same effect as a reduction in efficiency of a lamp. Years of research have gone into raising the efficiency of MAZDA lamps to their present high levels, and any lamp user who burns lamps at a sacrifice of efficiency, raises his own cost of light as shown in the diagram on the opposite page. Undervoltage burning makes him pay for light he does not get. Voltage at the socket should be checked during the time the lighting load is in use.

Life—Lamps may be designed for a life of many thousands of hours but the resulting inefficiency and waste of electric current would make them too costly to operate. Increased life may seem at first desirable in order to reduce lamp renewal costs; however, if long life is gained at the sacrifice of efficiency, the cost of light goes up. The lamp manufacturer must select some definite operating efficiency as the basis for the design and construction of the filaments used in the various lamps produced. This is done by determining, as well as possible, the conditions under which the lamps will give customers the most satisfactory and economical lighting service.

Lamps for the Theatre

General Service Lamps—Available in sizes from 15 to 1500 watts, these serve the majority of lighting applications. Except for the tubular bulb bipost lamps, all are designed for burning in any position; all are available with inside-frosted finish to diffuse the light, to eliminate filament striations, and to produce a smoother lighting effect; the



Relative importance of Lamp Price and Lamp Efficiency on the Cost of Light

frosting absorbs little light, in fact, inside-frosted and clear lamps (clear lamps are regularly available in sizes above 100 watts) have the same rating in light output.

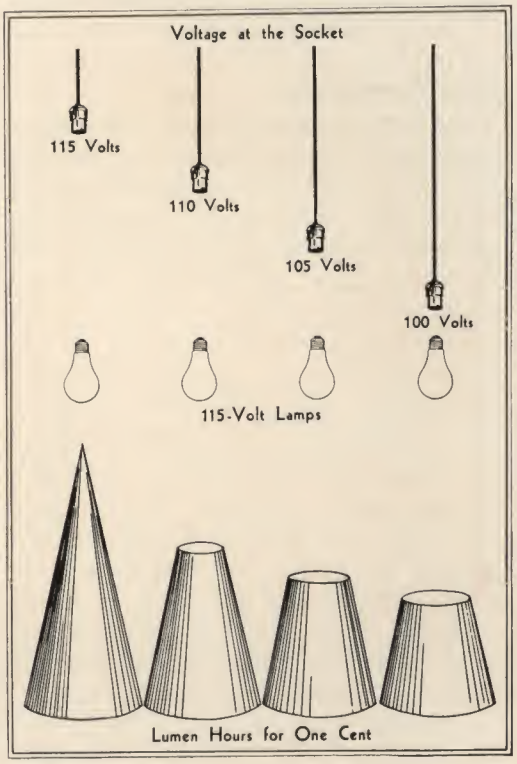
Inside-Colored Lamps for Sign and Decorative Service—The General Service lamps mentioned above are suitable for enclosed lamp signs and luminous displays where protected from rain and snow. For outdoor exposed applications a line of vacuum lamps from 6 to 50 watts is available in frosted and inside-colored which are intended principally for use where the lamps themselves are visible and form the pattern of the display. Natural colored lamps, available in four sizes and four standard colors, are more expensive than coated lamps but produce colored light at a higher efficiency.

Outside-Colored Lamps—Several sizes of outside-colored lamps are also listed in round and flame-shaped bulbs adapted to many decorative and ornamental fixtures. They are not recommended for outdoor use.

Lumiline Lamps—Available in colors and in 30 and 60 watts (length 17¾ inches) and 40 watts (length 11¾ inches) have by their physical shape introduced new concepts of decorative lighting design. They may be used exposed or in narrow reflecting and shielding equipment. The outside coated lamps are not recommended for exposed outdoor use. The standard colors are delicate pastel shades in white, straw, orange, moonlight blue, emerald and surprise pink.

Spotlight and Projection Lamps—These differ from the general line of lamps in the extreme concentration of the filament and the accurate positioning of the filament with respect to the base and axial alignment, as well as the type of bulb necessary to withstand high temperatures. Lamp life is sacrificed in order to get the maximum light output; spotlight lamps are designed for 200 hours life, projection lamps for 25 and 50 hours.

Three groups of lamps are available —a complete line of motion picture and stereopticon projection, as well as lamps specially designed for those spotlights and floodlights which require a high degree of accuracy in focusing and optical control of the light.



Brilliance, color and punch, so necessary to the theatre's use of lamps, are lost if the lamps are dim and weak due to undervoltage burning. The diagram opposite indicates the relative amount of light delivered for equal cost when socket voltages are 5, 10, and 15 volts below the labeled voltage of the lamps. Undervoltage burning may be caused by inadequate wiring and overloaded circuits, or it may be due to the use of lamps of higher voltage rating than the normal service voltage supplied to the theatre.

COLOR AND COLOR MEDIA

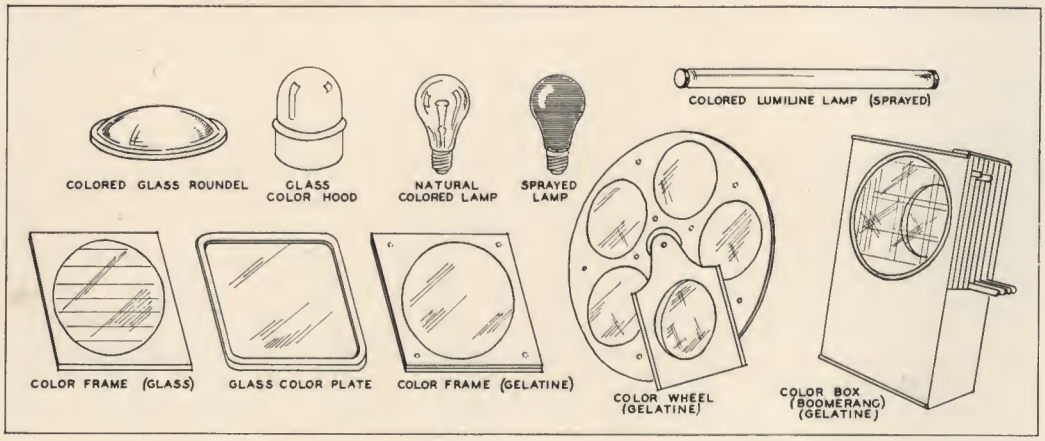
Probably no single factor exercises so definite an influence upon the atmosphere of every part of the theatre as does the manner in which color, both in lighting and other decorative media, is used. The lighting technician uses color to create atmosphere and moods. The theatre manager sees in color a means of attracting attention, holding interest, and creating advertising value in the midst of surroundings of competitive eye appeal. The architect and decorator uses color to achieve the decorative emphasis he is striving for. Color, though one of the most interesting aspects of theatre lighting, is too often misapplied.

White light, from the sun or an incandescent lamp is composed of several colors: red, orange, yellow, green, blue and violet, and all of the intermediate hues. Mixed together these colors make white light. Actually, by mixing only the three primaries of *light*, red, green and blue in proper proportions, white light results. However, by mixing the three primaries of paint—red, yellow and blue—a black pigment results.

Color Production

Colored light may be created by gaseous discharge sources, such as mercury, sodium and neon, and by the application of ultraviolet radiation to fluorescent materials. Gaseous discharge sources are each inherently of a fixed color eminently suitable for permanent and unchangeable display. White light sources contain all colors and any color or tint may be obtained at will by the use of colored transmitting filters. The resulting color output is, of course, dependent on the proportion of that color generated by the particular light source. From incandescent lamps, for example, about 5% is red, 5% green, and 1 to 2% blue. A rose tint, on the other hand, is produced at about 40% of the total light output. Similarly the other tints, and certain pure colors, yellow, orange, and "daylight white," comprise 50% or more of the normal white light. Tints or combinations of tints and lighter colors, often preferred, utilize the light from a MAZDA lamp to much greater advantage and at a considerably lower cost than is possible with pure reds, greens, or blues.

In general, some type of natural-colored glass filter, either in the lamp bulb or as an accessory, is more efficient and in most cases more effective than obtaining color by a colored coating or spray on the lamp. Initial output is better and this advantage is strengthened as the lamp ages. It is especially desirable to use natural-colored glass filters in obtaining green and blue. The accompanying chart summarizes some of the factors that influence the method of obtaining color from MAZDA lamps.



Devices for Producing Color

COLOR MEDIA FOR THEATRE SERVICE

		Colors Available	Purity of Color	Efficiency of Color Production	Initial Uniformity of Color	Permanence of Color	Maintenance of Light Output in Equipment	Cost of Producing Color	
								Initial	Over-all
APPLIED TO LAMPS	Natural-colored Lamps	Few	Excellent	Excellent	Fair	Excellent	Good	Average	Average
	Inside-sprayed Lamps	Limited number of standard colors	Fair	Poor	Fair	Fair	Poor	Low	Average
	Outside-sprayed Lamps	Limited number of standard colors	Fair	Poor	Fair	Poor	Poor	Low	Average
	Dipped and Lacquered Lamps	Many	Excellent	Excellent	Fair	Poor	Fair	Low	Average
ACCESSORIES	Color Caps and Hoods	Few	Good to Excellent	Good to Excellent	Good	Excellent	Fair to Good	Average	Low
	Colored Roundels and Plates	Few	Good to Excellent	Excellent	Good	Excellent	Excellent	High	Low
	Colored Gelatines	Many	Excellent	Excellent	Good	Poor	Good	Low	Average

COLOR APPLICATION

In applying color it is important to understand proper mixing for color harmony, which is a science in itself. Briefly, colors live by contrast; a single color, for example an all-blue auditorium, soon becomes monotonous and fatiguing, until the eyes fail to discriminate the color. By adding accents or highlights in another color, the contrast will heighten each of the colors.

Combinations of colors should be applied in an orderly arrangement; a hodge-podge of colors, either inside or outside of the theatre, spell an amateurish effect. Adhering to predominant single colors, with accents in contrasting color, is a good principle for many treatments.

Complementary colors, yellow and blue, red and green, blue-green and orange form the most striking and pleasing combinations, the contrast being greatest when the contrasting colors are close to each other. Closely associated colors, blue and blue-green, orange and yellow, etc., are also harmonious and effective.

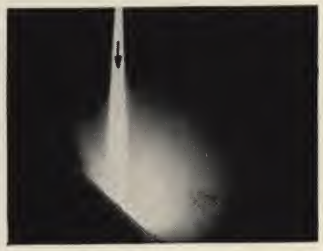
Color preference is a factor in the selection of color. In general, when selecting color for itself alone pure red and pure blue are preferred. In large amounts, however, pure red is not desirable, pure blue is better, but tints are still more preferable, especially when they must be lived with, as in a room or the interior of a theatre.

Through many years of association with certain colors in nature, man has developed a definite psychology of color. Some of the colors, the yellows, oranges and reds are "warm" and advancing. Blues and greens are cooler colors, receding, and seem to provide depth and spaciousness. Each color has its associations, red—blood, heat, anger, etc.; orange—harvest, fruition; yellow—gaiety, light, splendor; green—vigor, faith, youth; blue—dignity, hope, sedateness. Applying these associations—cooler colors in warm weather, warm colors in cold weather, colors suited to special presentations or occasions, and for special stage shows or musical numbers—the entertainment will be enhanced and the full value of color realized. Tints, in general, have a more pleasant effect on the appearance of people, surprise pink being particularly flattering to complexions. Then, too, there is the psychology of "bright lights." For a comedy presentation, for example, ample light in the auditorium contributes to a spirit of gaiety and makes merriment more contagious.

REFLECTING MATERIALS

The reflecting characteristics of materials greatly influence the illumination effect. Any project should therefore coordinate both choice of materials and method of lighting to achieve the desired result. On the opposite page is a demonstration grouping of common reflecting materials all lighted in the same manner as shown by the sketch at the top. While photographic reproduction does not record the appearance and brightness exactly as the eye does, it does show the range of effects. The various reflecting surfaces and materials are discussed briefly below.

Diffuse Reflection Surfaces



(Samples 2, 4 and 6)

The light rays are broken up and scattered in all directions. There are no bright spots and the surface appears evenly illuminated from any angle of view. Typical materials in this class are plaster, mat-paint, etched glass, honed marble, enamel and fabrics without sheen. Best reflection factors of white paints may range as high as 85 to 90 per cent. Colors and tints will be lower.

Specular or Mirrored Surfaces

(Samples 9 to 14)

Typical of the mirror or polished metals which mirror the image of the light source. Allows accurate control of light since the angle of reflection is the same as the angle of incident light. Such surfaces appear dark except when the angle is such as to receive the full force of the reflection when the image is only slightly less bright than the source itself. Brushing or corrugating the surface spreads the image at right angles to the brushing creating a spiked or banded effect. Pebbled or hammered surfaces produce a patch of highlights. Reflection factors range from 50 to 65 per cent for stainless steel and chromium, 75 to 85 per cent for processed aluminum, and 85 to 90 per cent for mirrored glass.

Diffuse—Specular Surfaces

(Samples 1, 3 and 5)

Typical of glossy paint, porcelain enamel, polished glass and marble, and shiny fabrics. Most of the light is diffusely reflected but the glazed or shiny surface reflects from 5 to 10 per cent of the light like a mirror, creating a spot of light on a diffuse luminous background. These spots may be of sufficiently high brightness to be spotty and glaring and unless definitely considered may defeat the quality of effect that may be planned.

Spread Reflection Surfaces

(Samples 7 and 8)

Typical of aluminum paint and oxidized aluminum sheet. While the light source is not definitely mirrored the light is spread so that the brightness of the surface is quite definitely related to the angle at which it is viewed. At one angle the surface appears highly luminous, at other angles quite dark. Reflection factors are of the order of 65 to 80 per cent.

1
WHITE PAINT
(GLOSS)

2
WHITE PAINT
(MAT)

3
POLISHED
MARBLE,
GLASS, ETC.

4
ETCHED GLASS,
HONED MARBLE

5
PORCELAIN
ENAMEL
(GLOSS)

6
ETCHED
PORCELAIN
ENAMEL
(MAT-FINISH)

7
OXIDIZED
ALUMINUM

8
ALUMINUM
PAINT

9
POLISHED
ALUMINUM

10
MIRRORED
GLASS

11
CORRUGATED
METAL
(POLISHED)

12
PEBBLED GLASS
OR METAL

13
BRUSHED
POLISHED
METALS
(VERTICAL
BRUSHING)

14
BRUSHED
POLISHED
METALS
(HORIZONTAL
BRUSHING)

TRANSMITTING MATERIALS

On the opposite page is a demonstration grouping of thirty different samples of light-transmitting materials, including a few of the many types of glass, plastics and synthetic materials, and thin impregnated marble. Behind each sample is a single lamp. Again the photographic reproduction does not record the brightness differences, and sparkle or color; however, it does indicate fairly well the three principal characteristics of translucent materials, namely (1) *ribbed or prism action*; (2) *spread transmission* in which the position of the light source shows through as a spot of light, and (3) *diffuse transmission* in which a sample appears uniformly lighted. The brightness of various samples is a function of their density and color. The three characteristics are discussed briefly below.

Ribbed or Prism Glass

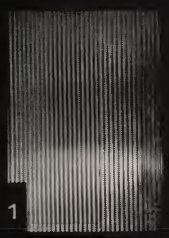
The lens action of ribbed, fluted, or prismatic glass refracts or bends the light rays producing a banded effect at right angles to the ribbing as shown in samples 1 and 6; other combinations of prisms will form other patterns as shown in 3, 4, and 5. Offers definite light control and is oftentimes useful in luminous elements, particularly in glass blocks for the interesting patterns of light and color formed by the flutings on the glass.

Spread Transmission

This is typical of frosted etched, hammered, or configurated glass, or very light density opal glass, where the rays are spread but are not sufficiently broken up to conceal the source and spottiness is apparent. Such materials offer a wide range of textures both lighted and unlighted and are used where accents of brilliance and sparkle are desired. They must be used with care to avoid glare and ragged appearance in the design. To avoid spottiness, the lamps may be shielded or so placed that the transmitted light is first reflected from the white diffusing sides of the cavity or recess.

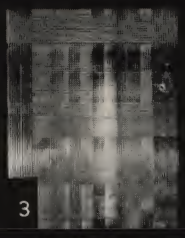
Diffuse Transmission

Typical of opal glass—cased or homogeneous—also of the thicker sheets of plastics, marble slabs, and enameled or fired glass. The light is spread so that the brightness appears equal at any angle of view; the appearance of uniformity is obtained when the lamps are spaced not to exceed 1½ times their distance back of the transmitting surface. Transmission efficiencies may run as high as 60 per cent for high quality white cased and enameled sheets, and for some of the white plastics. The thickness, density, and color affect the transmission efficiency.

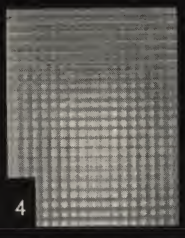


1 HEAVY VERTICAL PRISM

2 FLORAL CONFIGURATED (FLOREX)



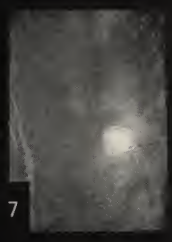
3 PRISMATIC PATTERNS (IMPERIAL G-7)



4 HEAVY FLUTED (MAGNALITE)

5 DIAMOND PRISM (REGLEX)

6 HORIZONTAL FACTORY RIBBED



7 DENSE RIPPLED OPALESCENT

8 CHIPPED

9 HEAVY ALABASTER

10 LIGHT CONFIGURATED OPALESCENT

11 HEAVY SYENITE

12 LIGHT TAPESTRY

13 SOLID OPAL

14 SOLID OPAL (MONAX)

15 CASED WHITE OPAL CRYSTAL BASE

16 SATIN FINISH ONE SIDE (LUMINEX)

17 SANDBLASTED TWO SIDES

18 SANDBLASTED ONE SIDE

19 WHITE CEL-O-GLASS

20 WHITE TRACING PAPER

21 CREAM PLASTIC (LUMARITH)

22 WHITE PLASTIC (LUMARITH)

23 PINK PLASTIC (CATALIN)

24 LAMINATED PLASTIC (TEXTOLITE)

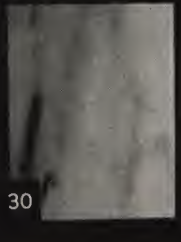
25 DAYLIGHT BLUE FLASHED WHITE OPAL

26 AMBER OPAL FLASHED WITH WHITE

27 1/8" ENAMELED GLASS

28 AMBER (VITROLUX)

29 SPECIAL ENAMELED DESIGN (VITROLUX)

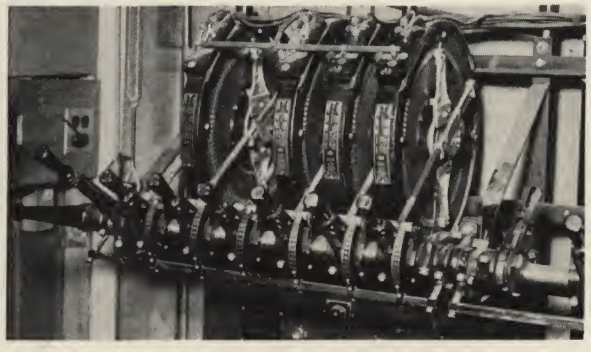


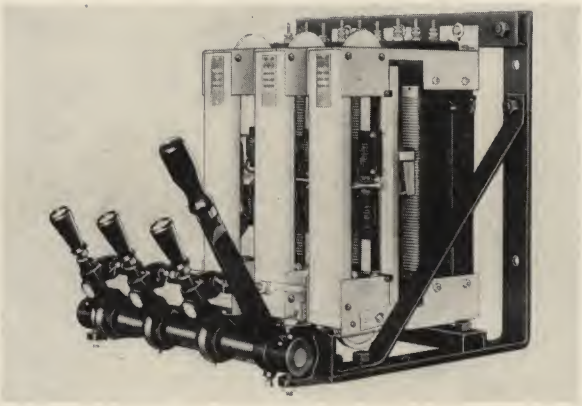
30 TRANSLUCENT MARBLE (LUMAR)

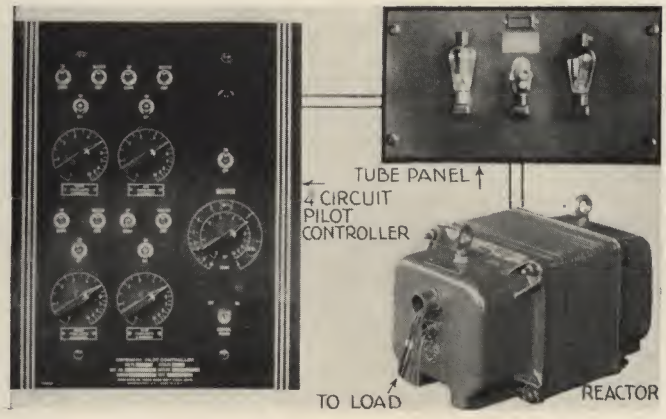
CONTROL SYSTEMS FOR THE LIGHTING OF THEATRES

In the theatre, both on the stage and in the house, lighting must be expressive and versatile. Colors are produced by blending primary colors; both quantity and position of the light regulate directional effects and shadows; brightness and quantity gradations of light must be produced smoothly, accurately and economically. The essence of atmospheric lighting is central control and flexibility, from full brightness to black-out.

To obtain such complete control the switchboard operator must be able gradually and easily to dim or brighten any lamp or group of lamps on the stage or in the house. Electrical devices called dimmers regulate the light output by varying the voltage impressed upon the incandescent lamp.







Resistance Dimmers

Resistance dimmers available both in slidewire and circular plate types, function by the absorption of the energy as heat. Overloads may cause damage, but they should be loaded to their capacity, otherwise the lamps will not dim completely nor will they dim at a rate corresponding to position indicators.

Slidewire dimmers have capacities up to 1000 watts; they are usually of inexpensive construction and are not ordinarily arranged for master control. Circular plate dimmers have a maximum capacity of 4000 watts, available in (1) inexpensive individual control models, and (2) in the heavy-duty theatre type arranged for master control. Some models comprise double plates with two control handles, others of a dual capacity type permitting variable loading. For remote control some types have individual motors connected to suitable master control. At least 100 contact points are needed to provide flickerless dimming. Care must be used in maintaining all contacts and moving parts: A "flipper" switch should be provided so that when the resistance is all in use, the circuit will be disconnected, thus conserving the electrical energy.

Auto-Transformer Dimmers

Auto-transformer dimmers reduce the voltage of lamps by a transforming action, thus being of high efficiency as contrasted with the resistance types. They are of the circular and slider type; in some cases not arranged for master control—in other cases arranged for manual master control as with the resistance types. The maximum size is 4000 watts, but this method of dimming has the advantage of being able to control any load up to the maximum. Another advantage is the freedom from heat problems. Care must be used in maintaining contacts and moving parts.

Thyratron-Reactor Dimmers

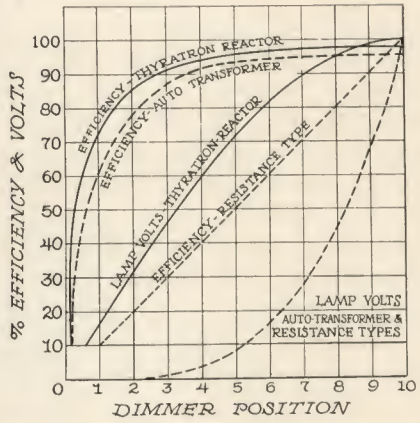
With Thyratron-reactor control the actual dimming is accomplished by the saturable core reactor in series with the load. The reactor has two windings, one in series with the alternating current load, the other to be activated by direct current. When no direct current is flowing, the

alternating current is "choked" and no current flows to the load. As direct current, up to a few per cent of the main load is applied to the d-c winding, the lamps brighten accordingly. The thyratron tube control acts as a rectifier to supply direct current to control the reactor; it in turn is controlled by a small resistance or solenoid pilot.

Proportional dimming is provided, assuring relative dimming of all circuits from any given brightness to black-out. A reactor will dim proportionately any load down to one-fourth of its rated capacity. Loads of any size may be accommodated.

The larger stages with 40 or more control circuits are usually arranged with a dimmer for each circuit. Dimmers are often built into the switchboard, in other cases they are operated by remote control. A master control is necessary for each color circuit together with one grand master control. For professional operation it is desirable to have several "pre-sets" or switch circuits allowing prearrangement of the lighting so that a change can be made with a master control handle. With the newer systems such as with thyratron tube control, the control handles are very small making the pilot switchboard small enough to be placed in the most desirable location such as in the orchestra pit affording the operator a full view of the stage.

Mobile control is possible with any of the types of dimmers mentioned. For such operation a pushbutton is used for master control and the various color circuits blend continuously and according to any predetermined color sequence as slowly or rapidly as desired. Such control



Comparative efficiency of Resistance, Auto-transformer, and Thyratron-reactor dimmers.

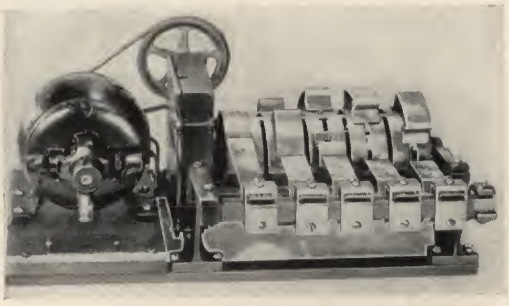
is suited to interior applications, intermission circuits in auditoriums, displays, lobby lighting, night clubs, ballrooms, etc. For exteriors it is suited to sign letters and borders, floodlighting and displays in general.

With the resistance and auto-transformer types, a motor or motors at the dimmers control the positioning of the dimmer handle, and by the adjustment of cams each dimmer may be adjusted to a predetermined cycle. With the reactor type, due to electrical control the problem is simplified as it is only necessary to operate the small pilot controllers, adjusted by means of a cam to any predetermined cycle.

Flashers

Mobile control of illumination is also provided by flashers where abrupt on and off, running and spelling motions are desired.

The simplest types of thermo-flashers are in the form of buttons and adapters used in ordinary sockets and are suitable to loads up to 100 watts. Other types are self-contained and wired into the



circuit. For large loads the thermo-flasher acts as a pilot to control a heavy-duty contactor switch. Speeds of 6 to 70 flashes per minute are possible though the speed is likely to be erratic.

Motor-driven flashers, such as the one illustrated, make and break contacts according to a predetermined cycle by the use of contacts that are part of an arc of a circle. Other types employ a cam arrangement. In the first arrangement any desired length of contact is used and the brush bearing on it to make and keep the contact. Any number of controls up to 20 amperes may be provided. With a cam arrangement, the cams operate arms which tilt mercury switches to make and break the circuit. In another case the cam-operated arms raise and lower silver contact points to make and break the circuit contact. Again, any number of circuits may be controlled.

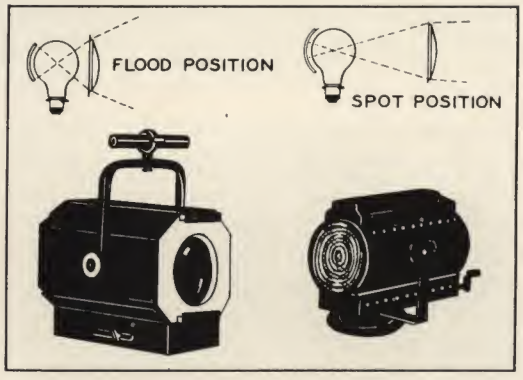
With the motor-driven types, simple on and off motion is provided by one or two contacts. Running motion is provided by a four-circuit flasher with contacts operated in rotation; a twinkling effect if the second and third circuits of the running motors are interrupted. Elaborate spelling effects require more contacts.

SPOTLIGHTS

Spotlights play an important part in theatre lighting. Whereas other equipments provide a permanent foundation of lighting, the spotlights add the final touch of highlight, pure color, or colored shadows. Their ability to put light where it is needed, their flexibility of control and adjustment, and the simplicity of their use make them very handy tools for the lighting technician. Spotlights are especially useful for floodlighting the entire apron of the stage from the balcony rail, for lighting the orchestra pit, for spotting a player from the booth and for special effects.

Spotlights should be equipped with lamps having some type of prefocused base to obtain best results and to eliminate difficult time-consuming adjustments. The filament of the lamp is accurately aligned in the factory and the base is aligned by the equipment manufacturer so that maximum light output is consistently assured.

LENS SPOTLIGHTS

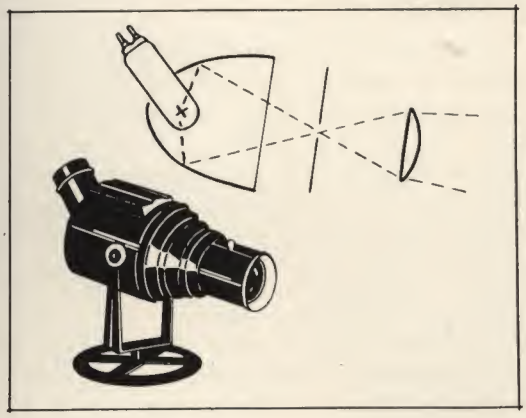


Many spotlights are of the lens type in which a plano-convex lens collects the light and concentrates it into a beam. By changing the relative position of the lamp and lens the size of the spot is easily varied. The larger the diameter of the lens, the more light is collected and redirected into the beam. Lenses of five to six inches in diameter are recommended for 250- to 400-watt spotlights and six to eight inch lenses for higher wattages. Spotlight housings should be of such length as to permit the use of lenses of the proper focal length—for average usage the focal lengths should be approximately twice the diameter of the lens, a six-inch lens having a 12-inch focal length, etc. Equipments necessitating lenses of too short a focal length, such as many baby spotlights, are limited in use to that of a modified floodlight. By specifying longer housings, permitting the use of lenses of the correct focal length, small spotlights as flexible as large spotlights are assured.

Where a higher efficiency of light output with somewhat lesser control of the beam and moderate size spots are desired, spotlights with Fresnel lenses are indicated. The designed surfaces of the lens makes it possible to operate the lamp closer to the lens and thus collect more light.

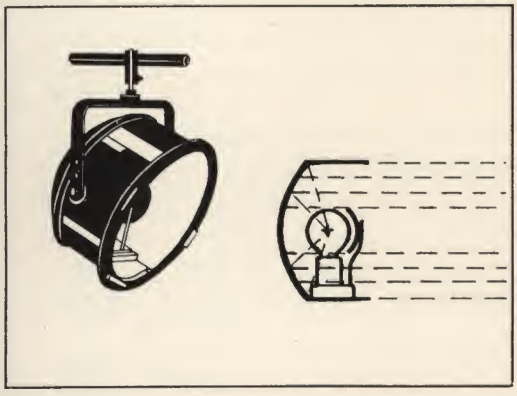
Spotlights of the lens type should usually be equipped with a truly spherical mirror correctly adjusted so that light to the rear of the housing is redirected back through the filament to the lens increasing the spotlight efficiency from 20% to 50%. The radius of the mirror should be approximately ¼ of an inch larger than the radius of the lamp with which it is to be used. There should be no screw holes in the mirror surface and, in order to prevent ghosts or distortions of the light beam, the edges of the reflector should be a flat black. A turned black metal edge is best.

ELLIPTICAL SPOTLIGHTS



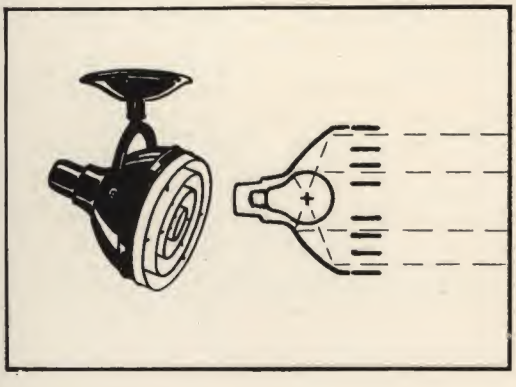
Spotlights with elliptical reflectors have great control flexibility and are considerably more efficient than lens spotlights in producing moderate or large size spots because of the greater angle of light pickup afforded by the elliptical reflector. The light from this reflector is concentrated at a secondary focal point and from there directed through a lens as in the lens spotlight. By changing the size of the opening at the conjugate focal point with a diaphragm, or the shape of the opening with shutters, the beam is changed in size and pattern. The 1000- to 1500-watt size is especially useful for long throws of 100 feet or more; the 250- to 500-watt unit is smaller in size and suited for average throws. Elliptical spotlights make use of some type of base-up prefocused lamp. Since they are most often directed from 10 to 75 degrees downward from the horizontal, the lamp is usually placed base up in the housing at an angle of 45 degrees from the vertical. When the lamp is in actual service it operates at or near the vertical, causing most of the blackening to collect at the top of the lamp and outside the reflector where it does not seriously reduce the light output.

REFLECTOR SPOTLIGHTS



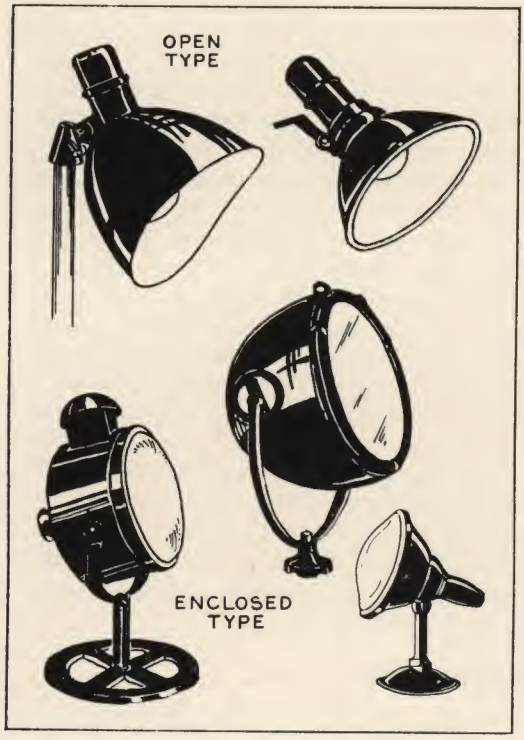
Reflector spotlights, equipped with shallow, long-focus parabolic reflectors provide maximum beam concentration (2° to 3° of beam spread) and 5 to 10 times the candlepower of other types. At flood positions, however, candlepower is drastically reduced, especially in the center of the beam. The reflector spotlight is especially good for long throws of 100 feet or more requiring highly concentrated spots of light. Spill rings, a redirecting spherical mirror, a concentrating lens, or a spill shield are necessary to eliminate spilled light.

SPOT-FLOODLIGHTS



Because of the larger amount of light intercepted by the reflector, a deep parabolic short-focus reflector with spill rings is more efficient than the shallow parabolic reflector spotlight or the lens spotlight. It is less flexible as to control and less suited to a narrow beam distribution. A specular reflector with properly formed louvers gives best results; finish of louvers from white to black varies the output considerably.

FLOODLIGHTS



Floodlights serve many purposes and a variety of designs is available, both in open and enclosed types, ranging in size from 100 to 1500 watts. For general-purpose floodlighting, the equipments for medium or wide angle distribution usually employ the standard general service line of lamps; for narrow beams and long throws, equipments employing shallow long-focus parabolic reflectors designed for the 250-, 500- or 1000-watt concentrated filament floodlighting lamps are recommended.

Open-type floodlights are widely used for outdoor areas such as parking spaces and for building facade lighting where wide angle distribution is suitable. Open floods generally of oxidized aluminum for stage lighting are usually equipped for use with gelatine color frames.

Enclosed type floodlights for outdoor use are desirable where the location and aiming is such that snow and rain would strike the lamp; depreciation is less and cleaning is simplified. Color glass roundels or cover glasses are used for color floodlighting.

BEAM SPREAD, BEAM CANDLEPOWER AND OUTPUT EFFICIENCY OF SPOTLIGHT AND FLOODLIGHT EQUIPMENT

Type of Equipment	CONCENTRATED			SPREAD		
	Beam Spread	Beam Candlepower (1000-W)*	Output Efficiency	Beam Spread	Beam Candlepower (1000-W)*	Output Efficiency
Plano-Convex Lens	3°– 5°	300,000	3– 5%	5° 80°	200,000 50,000	5% 20%
Fresnel Lens	10°–12°	200,000	8–15%	12° 50°	200,000 30,000	10% 40%
Elliptical	6°–10°	200,000	8–10%	10° 30°	200,000 150,000	10% 40%
Reflector (Shallow Parabola)	2°– 3°	1,000,000	5–10%	3° 20°	1,000,000 100,000	5% 15%
Spot-Floodlight (Louvered)	10°–15°	150,000	20–25%	10° 30°	150,000 150,000	20% 50%
Concentrating Floodlights	15°–30°	200,000	30–40%	.....	.....	.....
Wide-Spread Floodlights	.....	.....	.....	90°–120°	10,000	60–65%

* The beam candlepower for other sizes of lamps will be approximately proportional to their lumen output as compared to that of the 1000-watt lamp.

THE EFFECT OF COLORED LIGHT ON THE APPEARANCE OF COLORED OBJECTS

Natural Color of Object	Color of Light Illuminating the Object					
	Red	Orange	Yellow	Green	Blue	Violet
Black	Red Black	Orange Black	Yellow Black	Green Black	Blue Black	Violet Black
White	Red	Orange	Yellow	Green	Blue	Violet
Gray	Red Shade	Orange Shade	Yellow Shade	Green Shade	Blue Shade	Violet Shade
Red	Red	Scarlet	Orange	Brown	Purplish Black	Reddish Black
Orange	Red	Orange	Yellow Orange	Greenish Yellow	Black	Black
Yellow	Orange Red	Yellow Orange	Yellow	Yellowish Green	Greenish Black	Black
Light Green	Red Shade	Yellow Green	Greenish Yellow	Green	Blue Green	Bluish Shade
Deep Green	Black	Greenish Black	Yellowish Green	Green	Greenish Blue	Blue Black
Light Blue	Violet	Dark Gray	Yellowish Shade	Blue Green	Blue	Violet
Deep Blue	Purple	Blue Gray	Gray	Blue Green	Blue	Blue Violet
Violet	Reddish Black	Red Purple	Gray	Blue	Violet Blue	Violet
Purple	Red Shade	Red Shade	Red Shade	Black	Blue	Violet
Rose	Red Tint	Red Tint	Red Tint	Greenish Black	Blue Shade	Violet Shade

APPROXIMATE WIDTHS OF IMAGES PROJECTED BY LANTERN SLIDE PROJECTORS* OF VARIOUS FOCAL LENGTHS AND AT VARIOUS DISTANCES

Focal Length	Projection Distance—Feet											
	10	20	30	40	50	60	70	80	90	100	110	120
	Picture Width—Feet and Inches											
6″	4′10″	9′9″	14′9″	19′9″	24′9″	.....	.....	.....	.....	.....	.....	.....
8″	5′5″	7′3″	11′0″	14′9″	18′6″	22′3″	26′0″	.....	.....	.....	.....	.....
10″	....	5′9″	8′9″	11′9″	14′9″	17′9″	20′3″	23′9″	.....	.....	.....	.....
12″	....	4′9″	7′3″	9′9″	12′3″	14′9″	17′3″	19′9″	22′3″	24′9″	.....	.....
14″	....	4′4″	6′5″	8′7″	11′9″	12′11″	15′0″	17′2″	19′4″	21′5″	23′7″	.....
16″	....	....	5′6″	7′6″	9′5″	11′2″	13′2″	15′0″	17′0″	18′9″	20′8″	22′6″
18″	....	....	4′9″	6′5″	8′1″	9′9″	11′5″	13′1″	14′9″	16′5″	18′4″	20′0″
20″	....	....	4′3″	5′3″	7′3″	8′9″	10′3″	11′9″	13′3″	14′9″	16′6″	18′0″
22″	....	....	.....	5′3″	6′7″	7′11″	9′4″	10′5″	12′0″	13′5″	14′9″	15′10″
24″	....	....	.....	4′9″	6′0″	7′3″	8′6″	9′7″	11′0″	12′3″	13′9″	15′0″
28″	....	....	.....	.....	.....	6′7″	7′8″	8′6″	9′7″	10′10″	11′11″	12′11″
32″	....	....	.....	.....	.....	.....	6′8″	7′7″	8′6″	9′5″	10′4″	11′3″

* Size of slide and opening 2¾″ high by 3″ wide.

APPROXIMATE DIAMETER OF IMAGES PROJECTED BY SCIOPTICONS WITH SPECIAL WIDE-ANGLE LENSES AT VARIOUS DISTANCES

Focal Length	Projection Distance—Feet								
	10	15	20	25	30	35	40	45	50
	Picture Width—Feet								
4″	24	48	..	..	..	..	..	..	..
6″	18	32	44	56	..	..	..	..	..
8″	12	18	23	28	33	38	43	48	53
10″	8	12	16	20	24	28	32	36	40
12″	6	10	13	17	21	24	27	30	34

Effective diameter of opening—5 inches.

WATTAGE ESTIMATING CHART FOR THEATRE ILLUMINATION*

Applications		Theatre Seating Capacity	Recommended Foot-candles	Required Watts per Square Foot			
				Small Exposed Lamps	Luminous Elements	Indirect Lighting	Down Lighting
Under Marquee		2500 or more	100 up	40–50	40–50	Less effective for outdoor use	25–35
		1200 to 2500	50–100	20–40	20–40		12–25
		700 to 1200	30–50	12–20	12–20		10–15
		300 to 700	30	10–15	10–15		8–11
Lobby†		2500 or more	20	8–11	7–9	10–20	6–8
		1200 to 2500	15	5–7	5–7	8–16	3–4
		700 to 1200	10	3–5	4–6	5–10	2–3
		300 to 700	10	3–5	3–5	5–10	2–3
Foyer		2500 or more	5	4–6	3–5	6–12	3–4
		1200 to 2500	5	4–5	3–4	5–10	3–4
		700 to 1200	3	3–4	2–3	4–8	2–3
		300 to 700	3	3–4	2–3	4–8	2–3
Rest Rooms		2500 or more	10	Likely to be glaring	4–6	6–12	3–5
		1200 to 2500	5		3–5	4–8	2–3
		700 to 1200	5		3–4	4–8	2–3
		300 to 700	5		3–4	4–8	2–3
Lavatories		2500 or more	15	4–6	4–6	6–12	3–4
		1200 to 2500	10	3–4	3–4	4–8	2–3
		700 to 1200	10	3–4	3–4	4–8	2–3
		300 to 700	10	3–4	3–4	4–8	2–3
Passageways		2500 or more	2	Likely to be glaring	0.4–0.6	0.6–1.2	0.3–0.5
		1200 to 2500	2		0.4–0.6	0.6–1.2	0.3–0.5
		700 to 1200	1		0.2–0.4	0.4–0.8	0.2–0.3
		300 to 700	1		0.2–0.4	0.4–0.8	0.2–0.3
AUDITORIUM	Standee Spaces	2500 or more	1	Likely to be glaring	1–1.5	2–4	0.5–1
		1200 to 2500	1		1–1.5	2–4	0.5–1
		700 to 1200	1		1–1.5	2–4	0.5–1
		300 to 700	1		1–1.5	2–4	0.5–1
	Intermission	2500 or more	5	2–3	2–3	3–6	2–3
		1200 to 2500	5	2–3	2–3	3–6	2–3
		700 to 1200	5	2–3	2–3	4–8	2–3
		300 to 700	5	3–4	3–4	4–8	2–3
	During Pictures	2500 or more	0.1–0.2	Varies, depending upon type of lighting and especially color used. With three colors use wattage for each circuit corresponding to requirements for intermission			Dim intermission downlights
		1200 to 2500	0.1–0.2				
		700 to 1200	0.1–0.2				
		300 to 700	0.1–0.2				

* Above data based on average efficiencies of lamp and equipment in usual sizes of room and finishes of ceiling and sidewalls; it takes into consideration the additional wattage necessary to provide colors and tints as generally used in the various parts of the theatre. For specific calculations refer to Nela Park Engineering Bulletin LD-6A "Illumination Design Data."

† For advertising effectiveness, posters require approximately ten times the illumination of surroundings.